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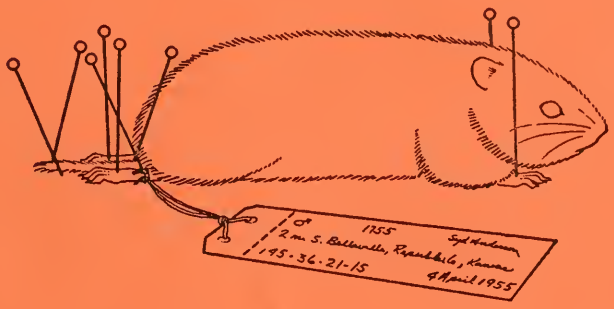
Collecting and Preparing Study Specimens of Vertebrates

by E. Raymond Hall



Museum of Natural History
The University of Kansas

MISCELLANEOUS PUB. NO. 30

Collecting and Preparing Study Specimens of Vertebrates

BY

E. RAYMOND HALL

UNIVERSITY OF KANSAS

LAWRENCE · KANSAS

UNIVERSITY OF KANSAS

MUSEUM OF NATURAL HISTORY

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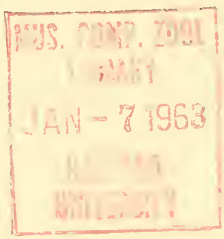

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RECENT VERTEBRATES

MAMMALS

In the first place the value of specimens is greatly enhanced by having them in excellent condition, and, of course, they must be accompanied by adequate data. Often a specimen may be well prepared and adequate data for it recorded, but subsequently, through faulty packing, incorrect method of labeling, or improper care and protection against pests and climatic conditions, it may be rendered worthless. Proper care at all stages of field work, therefore, is required to insure good quality in specimens. More details than are provided here on the techniques of preparing mammalian specimens are given in other authors' publications that can profitably be consulted. One of the best publications in this field is R. M. Anderson's "Methods of Collecting and Preserving Vertebrate Animals" (Bulletin No. 69, Biology Series No. 18, pp. vii + 164, illustrated, National Museum of Canada, Ottawa, Canada, 1960).

What to Collect

In preparing mammals caught, divide your efforts between common and rare species. As a rule, even with the more common species, save a pair from each locality. Series of up to thirty from one locality should be saved in each center of suspected differentiation—these to include young of different ages as well as adults.

Weathered skeletons or skulls of animals found may be desirable as specimens. For these, care must be taken to obtain all bones, and also teeth, as these frequently will have fallen out.

Contents of cheek pouches and samples of feces may be saved dry.

If lice, earwigs, flies, fleas, and other ectoparasites are to be preserved, it is desirable to examine not only the mammals but also their nests.

Plants to be saved should be placed in presses according to usual botanical practice. Seeds may be collected dry in any adequate containers.

Equipment and Proprieties

Mouse traps of the variety that snap shut on the animal can be purchased in almost every hardware store. These traps are satisfactory for shrews. For mice, however, the larger "Museum Special," manufactured by the Animal Trap Company of Lititz, Pennsylvania, is best because the wire that strikes and kills the mouse is far enough from the treadle to keep the head of the mouse from being struck and crushed. Broken skulls are less desirable than unbroken skulls. The still larger rat trap is stocked in most hardware stores and is suitable for taking animals the size of wood rats and small ground squirrels. Steel traps in sizes 0-4 are used in many areas to secure other animals. McAbee gopher traps are the best yet devised for taking pocket gophers. A variety of mole traps are on the market; the stabbing variety is preferred by most of the collectors that I know.

Many specimens are most effectively taken by shooting. For smaller and medium-sized kinds a shotgun is recommended, and, furthermore, shot of small size should be used in order to avoid unnecessary mutilation of the animal.

For many years the double-barreled 16-gauge shotgun has been a favorite of collectors; it is customary to carry a standard 16-gauge shell in the left barrel and a metal bushing in the right barrel. The bushing is drilled to chamber a 32-caliber metal shell loaded with No. 12 shot. The collector is ready to shoot animals of fox- or eagle-size with the charge from the left barrel, or mice, chipmunks, or small birds with the charge from the right barrel.

Nets of silk, such as are manufactured in Japan, are useful in capturing several kinds of bats.

Metal forceps, 10 to 14 in. long, frequently come in handy when bats or other small mammals have to be removed from crevices.

For safely storing prepared specimens in accessible fashion, a museum cabinet that excludes insects, dust, and light is essential. A visit to the nearest museum maintaining a collection of study specimens of mammals, or a letter of inquiry addressed there, will yield all needed information on the type of container best suited to the needs of the collector. Advice concerning the cleaning of skulls can be obtained from the same source.

Every state has its own laws relating to hunting, and the collector should obtain and read the laws so as to carry on his collecting in conformance with the law. The State Fish and Game office can provide a copy of the laws, and that office, in most states, is the place to apply for a "scientific collecting permit." The collector should also find and inform the local game protector of proposed collecting, because this can be of mutual benefit; the collector often receives valuable advice as to where certain species occur locally, and the Game Protector needs to know who is afield in his area and oftentimes obtains information valuable to him from the catches of the collector.

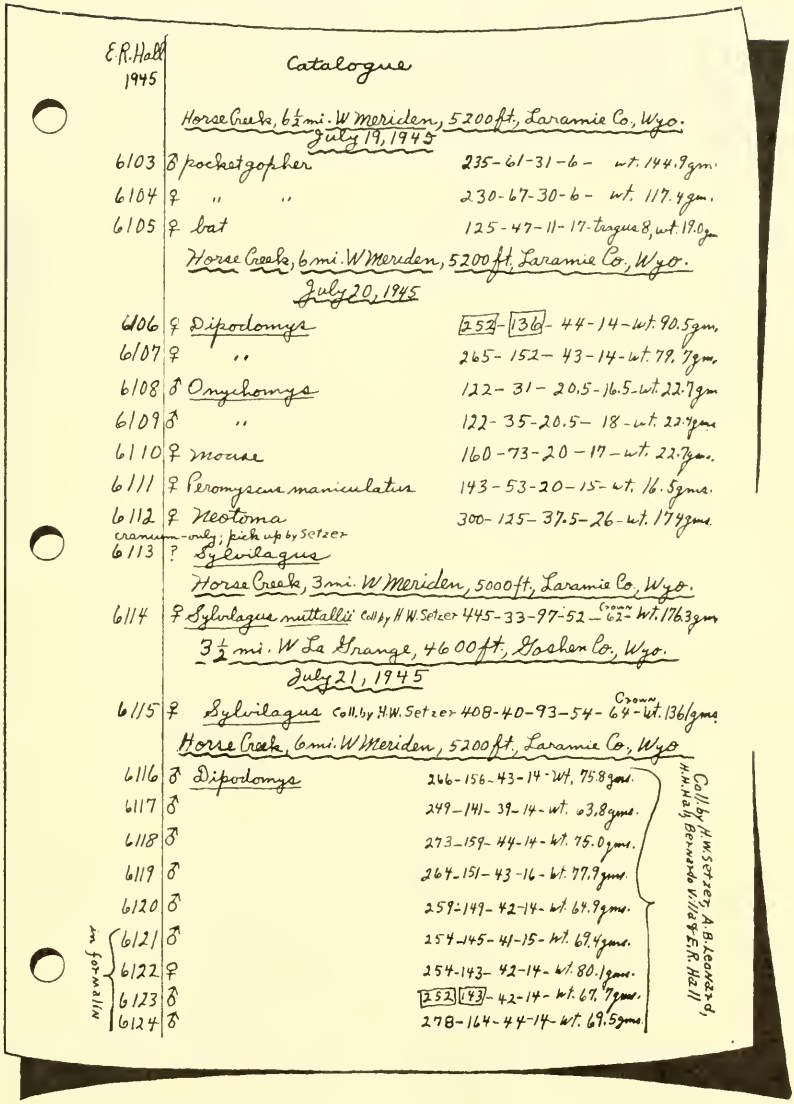
Wherever animals are collected on privately owned lands the permission of the land owner or his tenant must be obtained in advance. Application of the Golden Rule with land owners and the Game Protector will avoid trouble for the collector and bring him welcome assistance.

NOTE-TAKING

Field notes can usefully be divided into: (1) catalogue of specimens, (2) itinerary or journal, (3) accounts of species. Enter the name of the collector and the year in the upper left-hand corner of every page, but far enough from the margin to permit binding of the pages. Each page should be filled before another page is started. Use only Higgins Eternal Black Ink. For convenience all three sections of the notes ordinarily are kept in a single binder, but separate binders may be used.

CATALOGUE

In the catalogue, all specimens of vertebrate animals should be given consecutive numbers. Never repeat a number; for instance, do not begin a new series each year. One line of the notebook page should be devoted to the precise locality. Include distance in air-line miles from some well-established landmark. Include also elevation, county, and state. Devote one line to each specimen. If a specimen is not a conventional one, indicate the nature by entry directly above the field number, whether (if) skeleton, skull-only, skin-only, or alcoholic. Use the vernacular name of the species if you are not *sure* of the scientific name.



E. R. Hall
1945

Catalogue

Horse Creek, 6½ mi. W Meriden, 5200 ft, Laramie Co., Wyo.
July 19, 1945

6103 ♂ pocket gopher 235-61-31-6- wt. 144.9 gm.
6104 ♀ " " 230-67-30-6- wt. 117.4 gm.
6105 ♀ bat 125-47-11-17-tragus 8, wt. 17.0 gm.

Horse Creek, 6 mi. W Meriden, 5200 ft, Laramie Co., Wyo.
July 20, 1945

6106 ♀ Dipodomys 252-136- 44-14-wt. 90.5 gm.
6107 ♀ " 265-152-43-14-wt. 79.7 gm.
6108 ♂ Onychomys 122-31-20.5-16.5-wt. 22.7 gm.
6109 ♂ " 122-35-20.5-18-wt. 22.7 gm.
6110 ♀ mouse 160-73-20-17-wt. 22.7 gm.
6111 ♀ Peromyscus maniculatus 143-53-20-15-wt. 16.5 gm.
6112 ♀ Neotoma 300-125-37.5-26-wt. 174 gm.
cranium only; pick up by Setzer
6113 ? Sylvilagus

Horse Creek, 3 mi. W Meriden, 5000 ft, Laramie Co., Wyo.

6114 ♀ Sylvilagus nuttallii Coll. by H. W. Setzer 445-33-97-52 Crown 62 wt. 1763 gm.

3½ mi. W La Grange, 4600 ft, Goshen Co., Wyo.
July 21, 1945

6115 ♀ Sylvilagus Coll. by H. W. Setzer 408-40-93-54- Crown 64 wt. 1361 gm.

Horse Creek, 6 mi. W Meriden, 5200 ft, Laramie Co., Wyo.

6116 ♂ Dipodomys 266-156-43-14-wt. 75.8 gm.
6117 ♂ 249-141-39-14-wt. 73.8 gm.
6118 ♂ 273-159-44-14-wt. 75.0 gm.
6119 ♂ 264-151-43-16-wt. 77.9 gm.
6120 ♂ 259-149-42-14-wt. 64.9 gm.
6121 ♂ 254-145-41-15-wt. 69.4 gm.
6122 ♀ 254-143-42-14-wt. 80.1 gm.
6123 ♂ 252-143-42-14-wt. 67.7 gm.
6124 ♂ 278-164-44-14-wt. 69.5 gm.

all in formalin

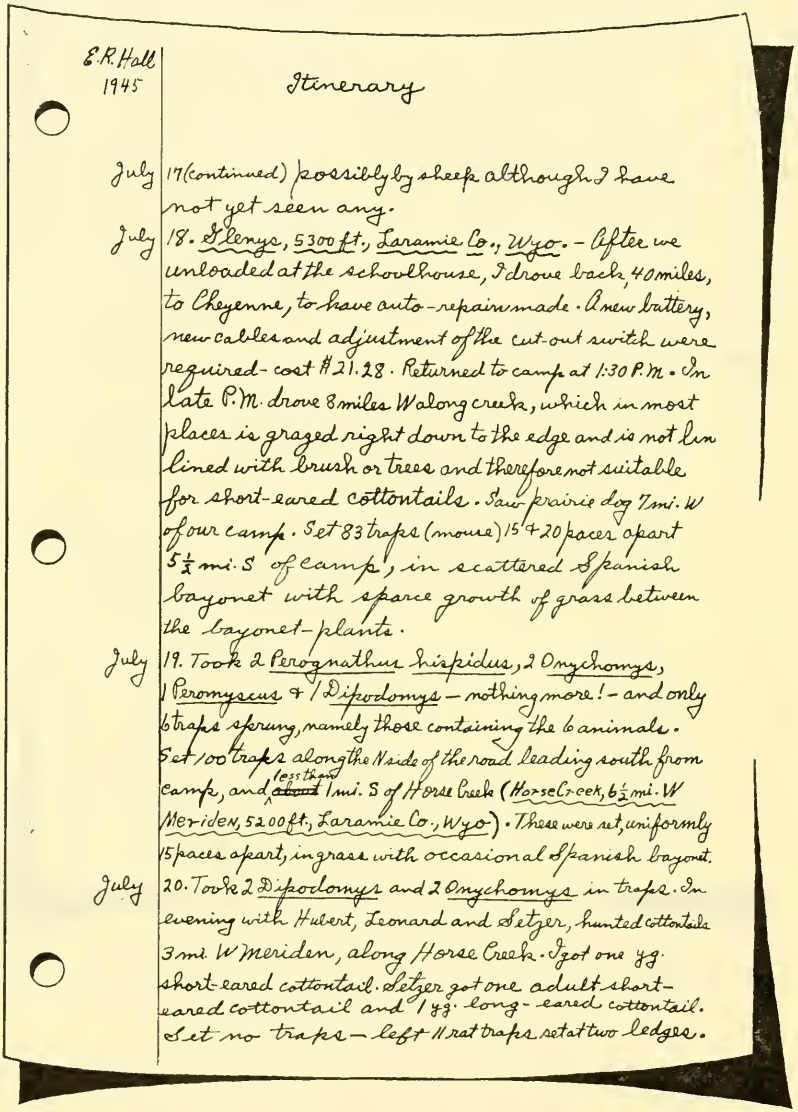
Coll. by H. W. Setzer, A. B. Leonard, H. H. Hall, Bernardo Villa & E. R. Hall

FIG. 1. A page from the author's field catalogue, slightly less than three-fifths natural size. Blue horizontal lines fail to show in this reproduction.

ITINERARY

On the first line of the itinerary enter date and locality. Follow with a concise account of route and travel area and habitats studied, and record number and kinds of traps set, distance between traps, number of vertebrates collected, as well as other pertinent information—for example, record number

of traps sets in each type of vegetation and numbers and kinds of animals caught therein. Section, township, and range comprise useful information. Sketch-maps can be included. Censuses of birds and censuses of other classes of vertebrates can better be included in the itinerary than in the accounts of species. Any general types of information that would have to be repeated if entered in other parts of the notebook are appropriate for the itinerary.



E. R. Hall
1945

Itinerary

July 17 (continued) possibly by sheep although I have not yet seen any.

July 18. Glenys, 5300 ft., Laramie Co., Wyo. – After we unloaded at the schoolhouse, I drove back 40 miles, to Cheyenne, to have auto-repairs made. A new battery, new cables and adjustment of the cut-out switch were required – cost $21.28. Returned to camp at 1:30 P.M. In late P.M. drove 8 miles W along creek, which in most places is grazed right down to the edge and is not lined with brush or trees and therefore not suitable for short-eared cottontails. Saw prairie dog 7 mi. W of our camp. Set 83 traps (mouse) 15 + 20 paces apart 5½ mi. S of camp, in scattered Spanish bayonet with sparse growth of grass between the bayonet-plants.

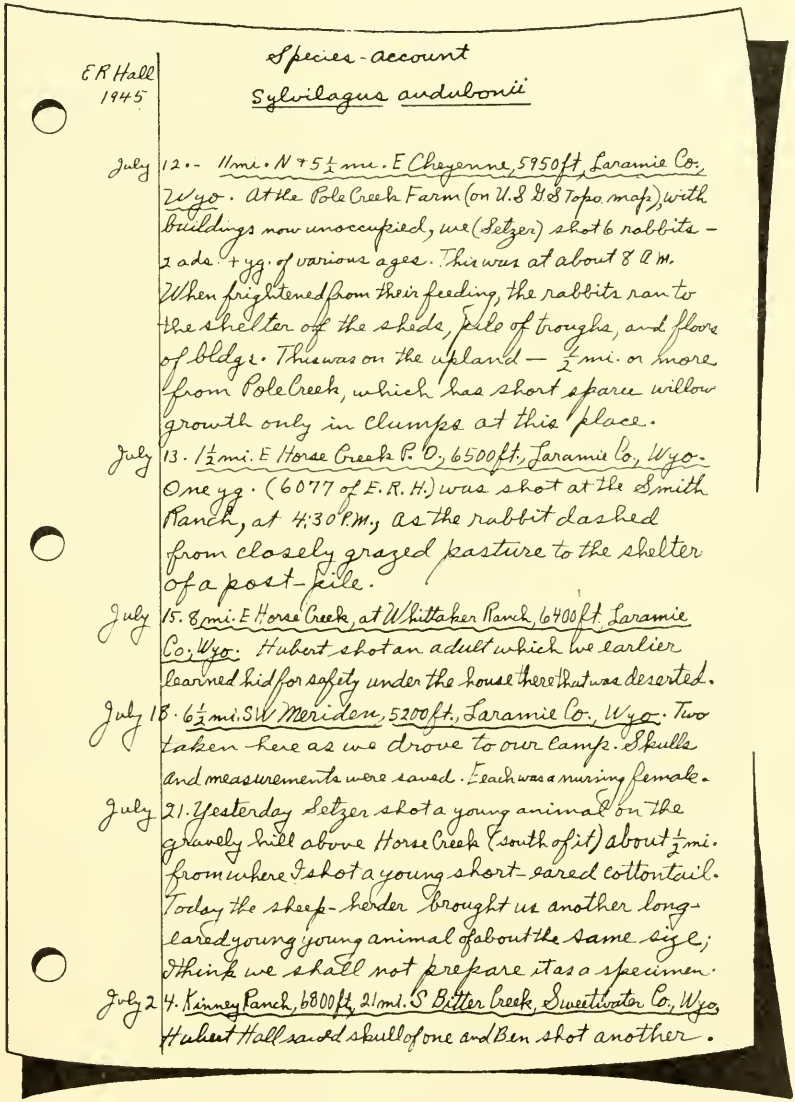
July 19. Took 2 Perognathus hispidus, 2 Onychomys, 1 Peromyscus + 1 Dipodomys – nothing more! – and only 6 traps sprung, namely those containing the 6 animals. Set 100 traps along the N side of the road leading south from camp, and ~~about~~ less than 1 mi. S of Horse Creek (Horse Creek, 6½ mi. W Meriden, 5200 ft., Laramie Co., Wyo.). These were set uniformly 15 paces apart, in grass with occasional Spanish bayonet.

July 20. Took 2 Dipodomys and 2 Onychomys in traps. In evening with Hubert, Leonard and Setzer, hunted cottontails 3 mi. W Meriden, along Horse Creek. I got one yg. short-eared cottontail. Setzer got one adult short-eared cottontail and 1 yg. long-eared cottontail. Set no traps – left 11 rat traps set at two ledges.

FIG. 2. A page from the author's field catalogue, slightly less than three-fifths natural size. Blue horizontal lines fail to show in this reproduction.

ACCOUNTS OF SPECIES

Accounts of species should be headed with either the scientific or common name, as preferred. The date and locality for the account should be given on the first line. Only one species should be written about on a single page. Information in the account should not be a repetition of material given in the itinerary or journal. Do not only include facts, but make interpretations and



E R Hall
1945

Species-account

Sylvilagus audubonii

July 12.- 11mi. N + 5½ mi. E Cheyenne, 5950 ft, Laramie Co., Wyo. At the Pole Creek Farm (on U.S.D.S Topo. map), with buildings now unoccupied, we (Setzer) shot 6 rabbits - 2 ads. + 4 yg. of various ages. This was at about 8 P.M. When frightened from their feeding, the rabbits ran to the shelter of the sheds, pile of troughs, and floors of bldgs. This was on the upland — ½ mi. or more from Pole Creek, which has short sparse willow growth only in clumps at this place.

July 13. 1½ mi. E Horse Creek P. O., 6500 ft, Laramie Co, Wyo. One yg. (6077 of E.R.H.) was shot at the Smith Ranch, at 4:30 P.M., as the rabbit dashed from closely grazed pasture to the shelter of a post-pile.

July 15. 8 mi. E Horse Creek, at Whittaker Ranch, 6400 ft Laramie Co., Wyo. Hubert shot an adult which we earlier learned hid for safety under the house there that was deserted.

July 18. 6½ mi. SW Meriden, 5200 ft., Laramie Co., Wyo. Two taken here as we drove to our camp. Skulls and measurements were saved. Each was a nursing female.

July 21. Yesterday Setzer shot a young animal on the gravelly hill above Horse Creek (south of it) about ½ mi. from where I shot a young short-eared cottontail. Today the sheep-herder brought us another long-eared young young animal of about the same size; I think we shall not prepare it as a specimen.

July 24. Kinney Ranch, 6800 ft, 21 mi. S Bitter Creek, Sweetwater Co., Wyo. Hubert Hall saved skull of one and Ben shot another.

FIG. 3. A page from the author's field catalogue, slightly less than three-fifths natural size. Blue horizontal lines fail to show in this reproduction.

generalizations. The accounts should be written in a style suitable for quoting in any publication. Accounts of species need not be restricted to kinds collected. If the account is about animals collected, it is wise to refer to the animals by your field-catalogue numbers.

Head each notebook page with collector's name and year, page number (if number system is used), locality (in *detail* the first time used), and date.

Write *full* notes, even at risk of entering much information of seemingly little value. One cannot anticipate the needs of the future, when notes and collections are worked up. The following are suggested topics, but do not restrict yourself to these alone. Be alert for new ideas and new facts.

Describe vegetation (saving plant-press samples of species not positively known), nature of ground, slope exposure, and drainage in each belt of animal life sampled. Describe exact location of trap lines, referring to your topographic maps, and also enter a sketch, in profile or surface view or both, to illustrate the location and relations of the different habitats crossed. Properly marked maps for each region worked should ultimately be bound in with the field notes of at least one member of your field party.

Keep full record of breeding data: number and approximate size (length) of embryos or of young found in nests. Dig out burrows if practicable; make drawings to scale, showing plan, and elevation; describe fully.

Record food plants; keep specimens for identification where not known by a definite name; preserve contents of cheek pouches and stomachs. If these are not saved, identify and record contents.

Note regularly in notebook all "pick-ups," that is, odd skulls or fragments of animals of whatever sort or source, serially numbered along with specimens of the more usual sort. Give full information, as with odd skulls secured from trappers. Label all such specimens adequately, as elsewhere described.

When leaving a well-worked locality, enter in the journal section of your field notes a summary of species observed, with remarks of a general nature, relating to local conditions of terrain, human activities, and other pertinent conditions.

Where feasible, interview old residents, trappers, National Forest and National Park rangers in each locality visited. Always record accurately the name, official position or occupation, and address of each person giving information; also give your opinion as to his reliability. Note general attitude of persons interviewed as to game laws, conservation, and effects of settlement by Man, and record specific comments, complaints, or criticisms.

In newly settled country, ascertain present numbers and distribution of large mammals as compared with their former status. So far as is possible get definite statements expressing ratio of present abundance compared with that of a definite number of years back. Seek information, where feasible, by indirect query. Do not risk influencing your informant's statements by leading questions. Record fully all evidence as to human influence upon original or "natural" balance. Record present economic relations of vertebrate animal life, that is, effect on agriculture and stock-raising, with full details. Note opinions of persons interviewed as to whether species should be protected or destroyed. Describe local methods of capture or destruction; give your opinion as to their effectiveness and justification.

Opportunity offering, record detailed observations on effects upon vertebrate animals of: severe storms; floods; forest, brush, or prairie fires; overgrazing; tree-cutting; road-building; or tree-planting. Some other matters on which

information can profitably be recorded in your species accounts concerning vertebrates include the following:

Markings and coloration (meanings apparent as associated with significant circumstances; directive, disruptive, concealing).

Speed (gait, climbing, swimming, walking, running, flying); tracks.

Abundance: by impression; censuses.

Plant associates: habitat; environment (define distinctive ecologic niche or biotope in which each animal is found).

Range (home range or "cruising radius" of individual, topographic and geographic range of species, indications of change in range).

Call-notes or voice (interpretations whenever circumstances give any clue); "songs" of birds.

Migrations (regular, irregular, local, altitudinal, geographical); movements and flight.

Degree of gregariousness (including "social instincts"); manner or means of communication (as voice, gesture, touch, and smell-signals).

Nests, dens and lairs; breeding habits (including number of young, length of breeding period, mating; whether promiscuous, polygamous, monogamous; relations of individuals of family group to each other); modes of locating nests or homes; sanitation; solicitude; reactions of young; care of young; mastology (distribution of mammary glands).

Boldness; belligerence; intolerance; shyness.

Food-habits; forage range; manipulation of food; storage. Scatology (dung or feces).

Acuteness of the various senses (touch, taste, sight, hearing, smell, and direction).

Enemies; disease (parasites, internal and external).

Odd partnerships; commensalism; any biotic interrelationships apparent.

Age (length of life of individual).

Refuges: from enemies; for resting or roosting.

Dormancy: hibernation or estivation; places where undergone.

Read above suggestions every week when on a field trip, devoting half an hour or so to thoughtful consideration of the objects of your field work, which probably are: To ascertain everything possible in regard to the natural history of the vertebrate life of the regions traversed, and to make careful record of the facts gathered in the form of specimens and notes, to be preserved for all time. All this is for the *information* of others; strive to make your records in all respects clearly intelligible. Remember that the value of your notes increases as the years go by and faunal changes take place. Some earlier note-books describe conditions now vanished in the localities with which they dealt.

LABELING OF SPECIMENS

Use one serial set of field numbers for *all* specimens (including "pick-ups," wet preservations, and ectoparasites).

Of course every specimen is to be fully labeled at the time it is prepared—and before the preparation of another is begun. A complete, authentic label for a mammal in most instances is scientifically more valuable than the skin to which it is attached. Beginners may not realize the prejudice engendered in careful zoologists by sight of a specimen unlabeled, incompletely labeled, or with a complete label unattached or insecurely attached to the specimen.

For each specimen always give altitude and county as well as exact place; for example: "3 mi. NE Lone Star, 850 ft., Douglas Co., Kansas." Attend minutely to proper punctuation. If not true NE, give miles north and miles east. Distances always to be air-line. Locality data to be given in notebook precisely as on specimen label.

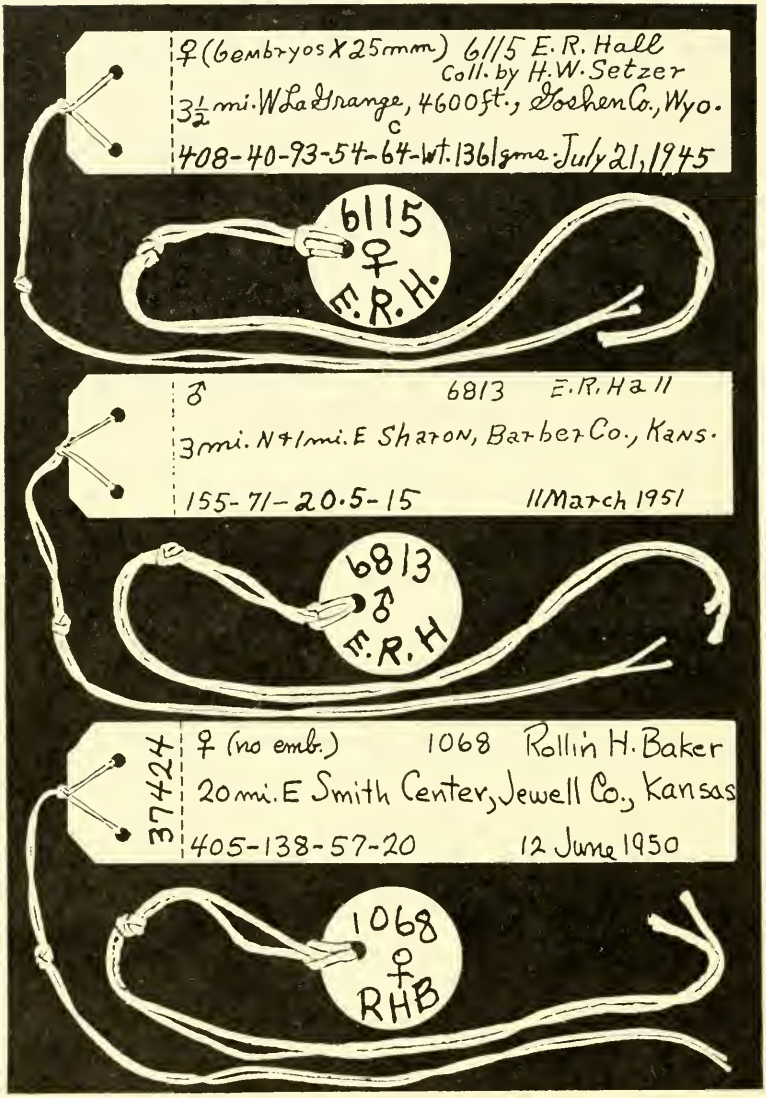


FIG. 4. Labels filled out. The rectangular labels are for stuffed skins; the round labels are for uncleaned skulls and skeletons. Actual size.

Record data on labels for skins on one side only (the opposite side is left blank for entering the name in eternal ink after laboratory studies have been completed). Enter data on three or four lines as may be necessary, and in the order indicated below.

On the first (top) line record sex (if female, record number and size of embryos or absence of embryos), collector's field number, and collector's name. Immediately following the field number record the name of the person to whom the number pertains, and preface the name of the second person with "Coll. by" or with "Prep. by" for the purpose of insuring that the field number will be associated only with the name to which it pertains and also to show which person was the collector and which one was the preparator. This information is important and especially so when necessity arises for tracing back through the field notes (catalogue, species account, or itinerary) to obtain supplementary information.

On the second line, or on the second and third lines, record the locality exactly as in the catalogue and other parts of the field notes—even to punctuation and abbreviation.

On the last line, record total length, length of tail, length of hind foot, height of ear from notch, weight in grams, and date. Use dashes (not commas, periods, colons, or semicolons) to separate the measurements. Use the abbreviation "gms." after the weight to show that the weight is recorded in grams instead of in grains or in ounces. Write out the names of months that are no longer than five letters; abbreviate the names of the others. Never use a numeral to represent the month, because doing so increases the chances of error in later transcriptions of the month and day. For example, depending on the country from which a person comes, the date of June 9, 1953, is written in at least the following forms: VI-9-1953, 6-IX-1953, 6-9-1953, VI-IX-1953, 9-6-1953; still other combinations are possible and may be used; even within different parts of one country (the United States) the form varies. Any one of the above combinations of numerals means Sept. 6, 1953, to some persons and June 9, 1953, to other persons; consequently it should be written "June 9, 1953" or "9 June 1953" in order to avoid error. Also use four numerals for the year (1953) and not an apostrophe and two numerals ('53) because the apostrophe can waste valuable time of the zoologist in ascertaining whether 1753, 1853, or 1953 is correct.

On a skull-tag enter field number, initials, and sex symbol with Higgins Eternal Ink; write *'large* and *heavy'* to prevent fading of the number and consequent loss of a specimen.

Attach tag to skull by running the string between the *lower jaws*. Tie with about ¼-in. slack in the string. Do not tie tightly around the lower jaw; there is danger of breaking the jaws of bats or shrews. Also, a loose string allows the larval dermestids to eat the meat directly between the string and jaw bone. Cut off the loose ends of the string.

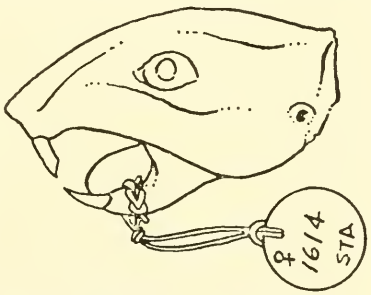


FIG. 5. Skull-label correctly tied to one ramus of the lower jaw of a skull freshly skinned out, immediately before skull is immersed in water. × ¾.

All miscellaneous material should bear labels with notebook references by specimen numbers, and initials of collector. Nests should be "threaded" and have labels attached to them

(not only to container). Folders for plants should each be inscribed with full data, according to usual botanical practice.

LABELS

Labels for skins. Paper used as labels should last for centuries, take ink well, hold ink well even when labels are immersed in liquids, and retain its strength in water or formalin or alcohol. At the Museum of Natural History of the University of Kansas we use, as best meeting the requirements mentioned above, "Resistall Index, Bristol 100 per cent rag." This paper has a weight of 110 lb. From sheets 25½ x 30½ in. we cut out the labels, after printing, that are to be attached to skins.

Stacks of 50 labels are firmly held in a metal frame of appropriate size, and two holes are drilled by means of a bit in a drill press near one end of the stack of labels. See figure 4 for exact position of the two holes.

For threading the labels we use Star Brand, white, 6-strand, mercerized, size-10 cotton thread manufactured by the American Thread Company. This thread comes in spools of 150 yd. to the spool. For stringing one label a piece of thread 330 mm. long is used. After the thread is strung through the two holes in the label, the loose ends of the thread are strung through a half-turn loop taken in the thread of the "backside" of the label. The threads are pulled taut, and a knot is tied in the two threads exactly one inch from the end of the label. This label and thread are recommended as satisfactory in all respects save one. The size of our label, in our opinion, is too large (see Figure 4). A width of 15 mm. and a length of 70 mm. would suffice. Predecessors established the size now used at the University of Kansas, and we continue to use it because the advantages of uniformity within a single collection outweigh the advantages that would be gained by changing to another size.

Threading of the labels is done by hand. A smooth flat board, say, 4 x 8 in., with the point of a finishing nail showing on one side at a distance of 1 in. from an ink mark facilitates tying the knot at the correct distance from the edge of the label. A skillful person can thread and tie 200 to 300 labels an hour.

Labels for skulls and skeletons are of a diameter (19 mm.) that fits loosely in the bottom of the smaller of the two sizes of glass vials used for housing skulls. These round labels are "Fiber Water Proof Stock, 10 pt." purchased from the Dennison Manufacturing Company of St. Louis, Missouri. The labels are perforated at one side and are strung with No. 5 linen twine, in which a knot is tied exactly 1 in. from edge of label (see Figures 4 and 5). If pressure is exerted when writing on these labels, the writing will be retained even though the labels are immersed in water, ammonia, or alcohol. This fiber stock yields labels that are resistant to dermestid beetles and their larvae—insects used to remove flesh from the osteological specimens to which these round labels are attached. Some other kinds of paper are eaten by dermestids if the paper becomes stained with blood.

Notebook paper that is high in rag content is used because its lasting qualities are thought to be superior to most other kinds of paper. Field notes containing observations of behavior of animals written "on the spot," and census counts of animals under natural conditions in areas that later are greatly modified by Man, have increasing value with the passage of time. Such records, therefore, should be on paper that will not deteriorate with age.

Before starting on a collecting trip, the collector makes certain that he has the best available topographic map for use in the field.

SKINNING AND STUFFING SMALL MAMMALS

Tools and supplies normally used are as follows:

Labels for skins
Labels for skulls
Higgins Eternal Ink (not Higgins Drawing Ink or Higgins India Ink)
Dip pen or fountain pen in which Higgins Eternal Ink can be used
30-cm. rule graduated in millimeters
Sewing needles
White (not colored) cotton thread, 2 sizes
Pliers with clean-cutting jaws and wire-gripping ends on jaws
Forceps with fine sharp points but having arms strong enough to permit of gripping solidly
Scalpel or razor-sharp knife blade
Carborundum sharpening stone
Scissors, surgical-type, with two sharp points
Cotton, long-fibered, resilient, in smooth bats
Arsenical powder or soap in wide-mouthed container
One shallow pie tin
White cornmeal or fine hardwood sawdust

Other supplies and equipment are optional and may include scraper for removing fat and a 3-cornered file for working metal.

Measure the mammal in millimeters and weigh it in grams. Experienced preparators take two measurements, write them on the label, take two more measurements, write them on the label, weigh the animal, and write the weight on the label.

The standard measurements for a study specimen are taken as follows:

Total length. Manipulate mammal so that it lies out straight (do not stretch it; guard against error that can result from a broken vertebral column), and measure distance from tip of nose-pad to tip of fleshy part of tail, excluding hairs that project beyond tip.

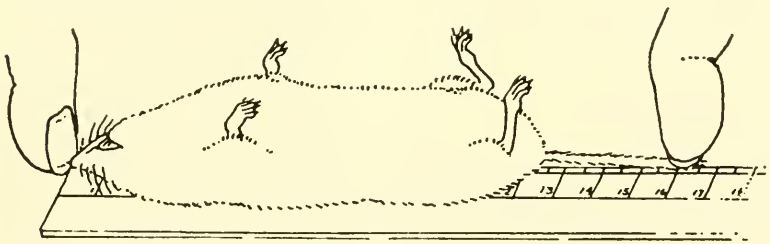


FIG. 6. Measuring total length of a small mammal. × ½.

Length of tail. Bend tail up at right-angle with body and measure from bend on back to tip of fleshy part of tail, excluding hairs that project beyond tip.

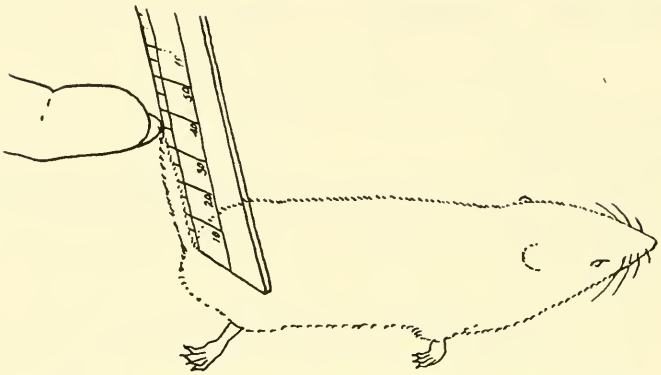


FIG. 7. Measuring length of tail of a small mammal. × ½.

Length of hind foot. With its toes out straight measure the distance from tip of longest claw to heel—in the same way that the over-all length of a person's foot would be measured. Outside of North America the claw is excluded from the measurement of the length of the hind foot, and only the fleshy part of the foot is measured in mammals from continents other than North America (Greenland, Panamá, and Central America are parts of North America).

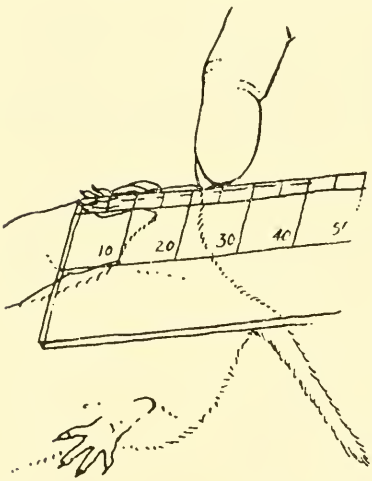


FIG. 8. Measuring length of hind foot of a small mammal by means of a transparent (plastic) rule. × ¾.

Height of ear from notch. Insert end of rule in notch at bottom of ear and measure to distalmost border of fleshy part of ear.

Next make out the labels (for skin and skull), and then make the entry in the field cataloue. It may be necessary to enter the sex (and certainly number and size of embryos if any) after the animal is skinned.

Fold a square piece of cotton or other stuffing to desired size and shape, and lay it to one side. A body too large or too small will cause trouble. A body wider than high and wider at the middle than at either end, to begin with, gives best results. Make the body one-fourth longer than the body of the animal (the extra fourth will be cut off later). The back and sides of the body should be smooth; small irregularities in the body make larger-appearing irregularities in the dried specimen. The outside edge of the cotton should be feathered; that is to say, enough of the fiber should be removed to make the cotton taper to a thin edge. When the last fold is made, drag the body across the skinning board or table top so as to cause the thin

edge of the cotton to adhere to the previous layer. So doing will prevent the body from unrolling while the skin is being turned over it; partial unrolling twists the skin, making it unsightly. The aim, whatever method is adopted for forming the body, is to obtain a symmetrical, firm, yet resilient body that will retain its shape while the skin is drying.

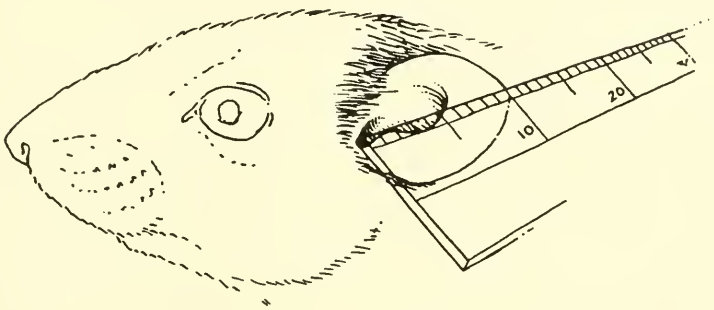


FIG. 9. Measuring height of ear from notch in a small mammal. × 2.

After the body is made, select monel metal wire of appropriate gauge; with pliers holding one end of the wire stretch a piece until it is perfectly straight. Cut and lay to one side five pieces, one piece for the tail and four pieces for the four legs. A leg-wire should be as long as the bony structure of the limb; wires for the two hind legs should be longer than those for the front legs. The tail-wire should be a half longer than the tail. For pocket gophers and wood rats use No. 20 wire; for a larger *Peromyscus* use No. 22; for small pocket mice use No. 24; for tails of the smallest bats use No. 24 or even No. 26 wire. Monel metal wire, or annealed tin wire, is to be used. Do not substitute other kinds of wire (not even copper, brass, or galvanized wire), because those eventually corrode or rust and destroy the specimen. If the correct kind of wire is not available, use split bamboo instead, and in any event use bamboo or other straight-grained, tough wood in place of wire in the legs of mammals larger than wood rats. Striped skunks and other mammals of equal and smaller size are to be stuffed; badgers, foxes, and larger animals are skinned so that the hides can be properly tanned and preserved unstuffed.

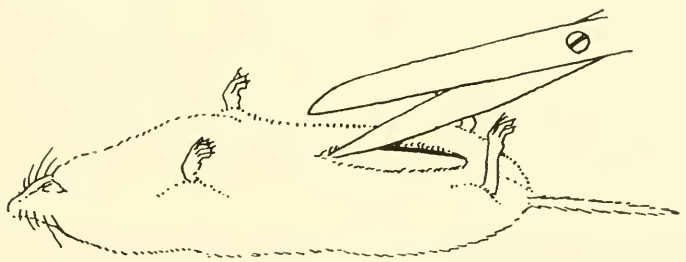


FIG. 10. Completing initial incision in order to allow skinning of a small mammal. × ¾.

Have ruler, threaded needle, scalpel, forceps, scissors, arsenic container, and pie tin containing a double handful of sawdust or cornmeal before you on a table or on a flat skinning board supported on the arms of a camp chair.

With the mammal held, back down, on the sawdust in the pie tin, use the scissors to cut the skin, and if possible not the body wall, on the midline of the belly from immediately in front of the anal opening forward one-fourth the distance (no more) toward the chest. Experience will enable you to make this cut by means of no more than two snips of the scissors, and to cut only the skin and not the body wall. Retain the scissors on the thumb and finger of one hand while proceeding so as not to waste time in laying down and picking up the instrument each time that it is needed.

With the free hand sweep sawdust onto the cut area. With the third and fourth fingers of the hand holding the mammal, thrust the knee toward the midline of the body, meantime pushing the skin of the belly and flank away from the midline by means of the thumb of the same hand. Grasp the exposed knee with the scissors hand, and with the forefinger and thumb of the other hand separate the leg from the skin and push the skin all of the way down to the ankle. Insert a blade of the scissors at the ankle in such a way that the bones of the lower leg are between the blades of the scissors, and in one motion by means of the blades of the scissors strip the flesh from the lower leg and free the lower leg by cutting it immediately below the knee joint. Repeat the process on the other hind leg.

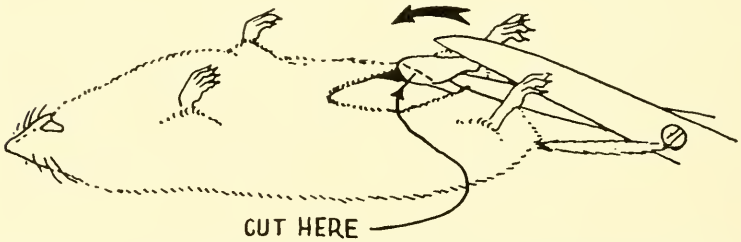


FIG. 11. Hind leg skinned out preparatory to severing leg immediately below knee. × ¾.

One reason for leaving the bones of the lower leg attached to the skin, instead of severing the hind leg by cutting through the ankle, is to meet the need that sometimes arises to measure the length of the dry hind foot. If the bones of the lower leg are present, the heel can quickly and certainly be located. If the bones of the lower leg are not present, there will be uncertainty concerning the heel: Was it cut away with the bones of the lower leg? If the heel is located, is all of it present? To answer such a question, it is necessary to relax the skin of the hind foot, cut the skin, and visually inspect the bones. These time-consuming operations can be avoided by leaving the bones of the leg in the skin.

Meanwhile, and throughout the whole of the skinning, keep the specimen buried as much as possible in sawdust, because the sawdust absorbs the fat and any body fluids, thus preventing them from getting on the fur or on the hands of the preparator. If the fat gets on the hands of the preparator, it

will be transferred to the fur. Fat on the fur makes the pelage unsightly and spreads eventually to the label and other specimens; fat anywhere on the preparation oxidizes and in time destroys the skin. To keep the specimen immersed in sawdust (or white corn meal) requires that the preparator learn to work as much as possible by touch instead of by sight. Beginners seldom use enough sawdust. The thought that "if some is good more is better" really applies to the use of sawdust in skinning mammals. After eight to ten small mammals that are exceptionally fat are skinned in a small quantity of sawdust, it becomes saturated with grease. Discard it and use fresh sawdust.

When the two hind legs have been freed and skinned out in the manner described above, separate the skin from the body wall by working a finger, or the handle of a scalpel, between the skin and the body. With the fingernails sever the gut and associated connections of the skin to the body. Scissors or scalpel can be used, but time is saved by using the fingernails. When the skin is free all around the base of the tail, place three fingernails behind the skin and push it off the tail. One motion will do the job. Take care to keep the nails against the tail vertebrae and behind the skin so as to avoid the misfortune of having the skin of the tail turn inside out; this misfortune slows down even the experienced preparator and is one that may be insurmountable for the beginner.

When the skin is free from the tail and hind legs, separate the skin from the body wall at the anterior end of the initial incision that was made on the belly. Then turn the skin down all around the body and push (don't pull) it off the body. Be sure that the skin is reflected (turned down) on the belly as well as elsewhere; otherwise the skin will gradually tear forward from the front end of the initial incision on the belly as you proceed with the skinning, and that misfortune causes the skin to fit improperly on the cotton body, with the result that the dried skin of the specimen will be misshapen. Push the skin down until the mammal's elbows are in sight. Tear or cut the thin skin-muscle that shows up. Push the skin down to the wrist. Straddle the forearm near the wrist with the blades of the scissors; in bringing the blades of the scissors up from the wrist almost to the elbow, strip the flesh from the lower leg and cut the bones immediately below the elbow joint. Do the same with the other foreleg. Drop the scissors, because you will not need them again in skinning this mammal. Push the skin farther until the bases of the ears come into view. By means of the fingernails securely grasp the ear tube on two sides where it emerges from the bone and pull the tube free. When the two ears are free, push the skin forward until the eyes are reached. Pick up the scalpel or knife and make two cuts on each eye: one cut straight down across the eye to sever most of the attachments of the skin to the skull, and a second cut on a transverse plane, with the blade of the scalpel against the bone so as to sever the lower (front) angle of the eye from the skull. Care has to be used in making the last cut, or the lids at the angle of the eye will be cut, with the result that the eye opening will be unnaturally large in the stuffed skin.

Push the skin to the tip of the lower jaws, sever the skin of each cheek, and then separate the skin from the front of the jaw by means of three slices of the scalpel or by means of three tears made with the fingernails. By means of the thumbnail push the skin on each side of the rostrum (forepart of the

skull) to the tip of the nose. Cut the skin free by a stroke of the scalpel, taking care to cut well ahead of the tips of the nasal bones. Beginners often cut off the ends of the nasal bones and are especially apt to do this if scissors are used instead of a scalpel.

With experience, less than a minute should be required to skin a mouse; that is to say, no more than a minute need elapse from the instant when the first incision (cut) is made on the venter until the skin is freed from the tip of the nose.

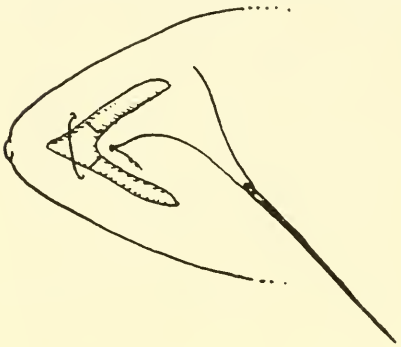


FIG. 12. Stitch used to close mouth of a skin. × 1.

Note the sex. If the specimen is female, note the absence or presence of embryos. If embryos are present, note the number and length from crown to rump. Complete the entries on labels and in catalogue. Attach the skull-label to the skull and drop it in water.

With scalpel in hand go over the skin, laid flat on the sawdust, to remove any fat. Remove it all. Fascia or small bits of red muscle are not worth removing. Grasp threaded needle; sew up mouth with a triangular stitch, and secure with a knot to prevent the stitch from coming loose. Cut the thread above the knot. Tie a knot with one hand at the end of the thread, and place threaded needle where you will reach for it the next time it is needed. To all parts of the flesh-side of the skin now apply arsenical soap by means of a brush, or apply powdered arsenic by means of a wad of cotton held in forceps.

In each foreleg thrust a wire along the bone of the foreleg into the palm and to the base of the nail of the middle finger without perforating the skin. Begin at the wrist with a thin wisp of cotton, and wrap the bone of the lower leg and wire firmly together. Moistened fingers will secure the cotton at the upper end of the wrapping. The foreleg shaped from cotton should be smaller than the original foreleg.

By means of the forceps pick up a cotton body. Place the outer seam down. By means of the closed forceps press down on the center of one end of the roll of cotton; with a finger and the thumb of the free hand press inward each side of the cotton at the same end; maintain pressure of the thumb and finger on the two sides of the end of the body; transfer the forceps, now opened, to the outside of the finger and thumb, and by means of the forceps constrict the cotton. Repetition of the maneuver forms a firm, sharp-pointed, symmetrical end, pointed downward. Holding this pointed end by means of the forceps, place the nose-pad of the skin (still flesh-side out) against the pointed end of the cotton body; turn the skin over the cotton body as far as the forelegs, meanwhile maintaining the grip with the forceps on the pointed end of the cotton; set in place the skin of the head and neck by tugging (not strongly enough to tear it) at the skin in the area of each eye, the skin of the throat, the skin around each ear, and the skin of the chest,

making certain that the hard pointed nose of cotton is all the way to the tip of the nose, that the two eye openings are symmetrically set, that the ears are exactly opposite each other, and that the skin of the head is fully stuffed. Then release the grip of the forceps. If the head end of the cotton body was correctly formed the cotton will expand and thus fill out the skin of the head and cause it to be bilaterally symmetrical.

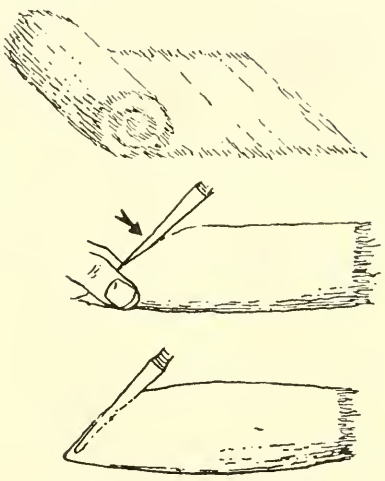


FIG. 13. Folding cotton to make a body, and shaping the end of the body by means of forceps and thumb and forefinger so that the body will fit properly in the nose of the skin. × ⅓.

Handling the body and skin as little as possible, turn the remaining part of the skin over the body, which should be slightly longer than the natural body. With scissors cut off the surplus end of the body but leave a thin extension on the back (top) side. See that the cut is exactly vertical and exactly transverse. Let the thin extension of cotton from the back cover the cut end.

Rotate each hind foot one-half turn outward. Then wire each hind leg in the fashion described above for the forelegs. Pull the hind feet out behind. The soles should be down. The skin of the hind leg should be stuffed so that the circumference of the lower leg and thigh is the same as it was in life. The wrapping that binds the wire and bone of the lower leg together should be long enough and frayed enough at the upper (proximal) end to make a gradual blend with the cotton body.

Pick up the tail-wire, moisten one end, twirl (by rotating the wire) on a thin strand of cotton, continue twirling so as to wrap a strand of cotton of gradually increasing diameter on the wire. The tail on the skinned body is a pattern for size. Remember that projecting ends of fibers cause the artificial tail to be functionally larger than it appears to be. Consequently, the wrapped tail-wire should seem to be of a slightly lesser diameter than the actual tail that has been slipped out of its skin. If the cotton is firmly anchored at each end of the tail-wire and if the diameter is exactly correct, all will go nicely. Hang the unstuffed tail down over the near edge of the skinning board (or table), dust some arsenic on the artificial tail, place the tip of the tail-wire into the open base of the tail, and then in one continuous movement thrust the tail-wire all the way to the tip of the skin of the tail—almost to the tip is not sufficient, because any unstuffed part will wither and be broken off.

With wire cutters snip off only as much of the free end of the wire as can not be got through the slit in the skin of the belly. The wire should lie on the midline of the underside of the cotton body between it and the skin.

Adjust the four legs so that the pairs are symmetrically placed and so that the leg-wires lie parallel to the midline and as close to it as tension on the

skin will permit. See that the tail-wire is lined up properly—parallel with the leg-wires and on the midline of the belly midway between the wires of the two hind legs. All of this should be done without picking up the stuffed skin; unnecessary handling at this stage makes the body misshapen. Next sew

FIG. 14. Sewing together cut edges of a stuffed skin. × ½.

up the slit in the belly. This is to be done by first catching the very edge of the cut edge of the skin with the needle; three or four diagonal cross-stitches should suffice. After the last one is taken, pull the whole lot tight; throw a loop in the thread, and by means of the points (closed) of the scissors run the loop down to the fur side of the skin to form a knot that prevents the stitches from pulling out as the skin dries. Cut the thread close, say, 2 mm. above the knot. Before returning the needle to the place selected for it, tie a knot in the thread so that it will be ready for instant use to sew together the lips of the next specimen that will be stuffed.

Lay the stuffed skin belly-down with hind feet projecting over the near edge of the skinning board. Tie on the label above right heel; take double turn (on the thread, not the leg), pull the thread almost as tight as possible without breaking it, complete as a square knot or tie four alternate granny knots. Cut off the loose ends of the string. The aims are first to tie the knot so snug that it will not slip off after the diameter of the heel and foot has decreased owing to drying out, and, second, to tie the knot so secure that it will have to be cut to remove the label.

Use a toothbrush having soft bristles to comb the pelage.

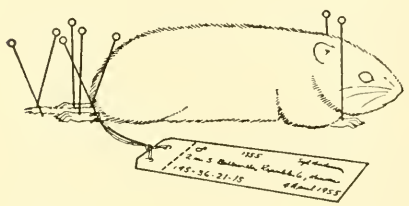


FIG. 15. Stuffed skin pinned down to dry. × ⅓.

Select 8 glass-headed pins no longer than the depth of the drying tray. Pin down the skin in the form shown in Figure 15. Pin down the forefeet first, seeing that each foot has the palm flat down on the board. The forefeet should be underneath the head well toward the midline of the body. Slant the pins outward so that they will not crease the skin or fur of the sides of the head. Next pin down the base of the tail by crossing two pins over it, in the fur at its base instead of over the bare part of the tail. Line up the tip of the nose, base of the tail, and tip of the tail; then pin down the tip by means of two crossed

pins. Finally pin down the two hind feet. Inspect the stuffed animal from the rear to see that the two hind feet are equidistant from the tail; inspect from the front to see that the two forefeet are equidistant from the nose, and inspect from each side to see that the tips of the toes of each pair of feet are correctly arranged in anterior to posterior position.

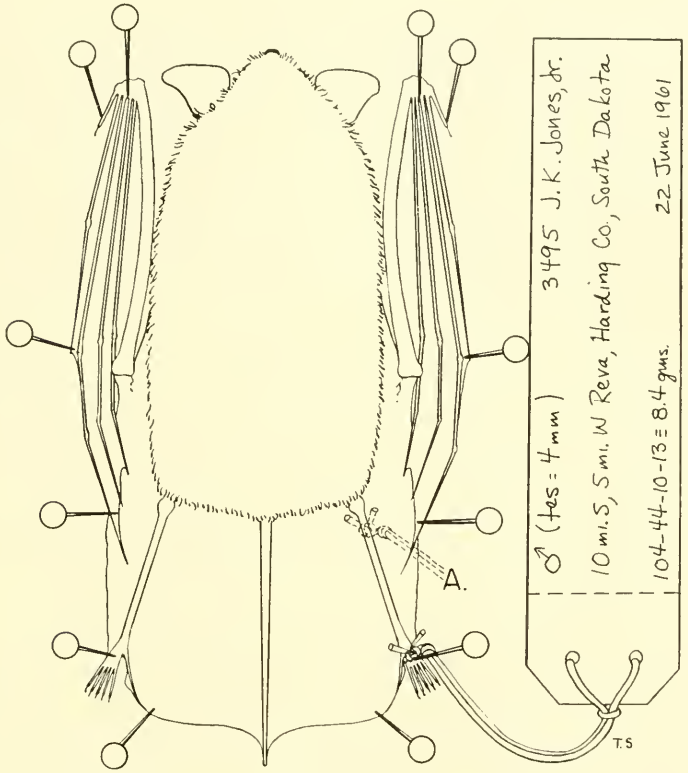


FIG. 16. Completed skin of a bat pinned down to dry. × 1.

By means of a pair of forceps, or by means of a thumb and forefinger, compress each external ear so that the two ears will be creased exactly alike. This helps in causing them to lie down flat as they dry, and if the treatment is repeated on the following day, the ears are more likely to be symmetrical when thoroughly dry.

Use a metal pin, the back of a scalpel, or the sharp edge of forceps to smooth the pelage. Set the tray where the skin can dry in a shady, airy place safe from animals and storms. Two days to two weeks later, whenever the skin is thoroughly dry, it can be unpinned. The amount of humidity has most to do with the time required for drying; in a hot, dry desert, rodent skins may dry in 24 hours, but in a humid, hot, tropical setting, the skins may never dry unless artificial heat is used to drive out the moisture.

With practice the average preparator can complete a specimen in twelve to fifteen minutes. The most rapid preparator that I know did the job in slightly less than five minutes. He, however, could not maintain that pace and actually turned out approximately eight specimens per hour. Self-analysis reveals to the beginner that he is making unnecessary movements. Attention to the elimination of superfluous movements probably is the best method of increasing the speed of preparation.

Bats can be prepared more quickly than other mammals because no wires have to be inserted in the limbs; the bones are left in place in order to provide the necessary stiffening. A wire is used in place of the tail-vertebrae. Pinning specimens in the fashion shown in figure 16 causes them to be of maximum usefulness. The fingers need to be spread enough to allow a mammalogist to measure each phalanx of each digit but should not be spread more than necessary. Note proper position of thumb. My colleague, J. Knox Jones, Jr., prefers to tie the thread of the label around the proximal part of the tibia (see A of Fig. 16) because tying the thread around the ankle distorts and partly conceals the calcar of the right foot on many specimens. More pins than are shown in figure 16, of course, can be used if necessary to fix the stuffed skin in the desired position.

Many persons have suggested means of saving the skins of small mammals without stuffing them, or means of partly stuffing them, as for example with only a piece of flat cardboard. Such skins are less useful for studying geographic variation and speciation than those prepared by the method described above, because such studies require comparisons of the new specimens with old specimens—specimens prepared in earlier years. Satisfactory comparisons are made only with specimens prepared in the same form. Since nearly all of the specimens from the past were prepared according to the method described above, specimens to be saved now are most useful if they also are prepared as described above.

An exception of a sort is made for rabbits in that the artificial bodies are prepared in a fashion different than that described above. The approved method is the following: Cut a piece of currugated cardboard for the center of the body; attach a straight stick to the cardboard at two places by means of wire or twine so that the stick strengthens the cardboard and projects far behind the cardboard to form a paddle; cover the cardboard with a thin (¼-in.) layer of smooth cotton bringing the two edges of the cotton together on the midline of the belly-side of the body along the stick; turn the skin, prepared in the usual way even to the legs, over the flattened body; with heavy shears cut off the posterior end of the cardboard to an appropriate shape; by means of monel metal wire or a large sacking needle and twine sew through each hind foot around the stick at two places so that the stick will support the two hind legs; with a single stitch secure each forefoot to the skin of the throat; sew up the slit in the belly; thrust a single pin (to be removed when the skin is dry) through the tip of each ear to secure the ears in the desired position; tie the label on the right hind leg; lay the skin away to dry. The skin need not be pinned down. Some advantages of this method are that it provides maximum support for the long hind legs which are wobbly and subject to breakage if otherwise prepared; a flattened body that is strong allows the specimen to be stored in less space than would be required

if the body were deeper; and the method requires a minimum of time for stuffing.

Flattening the bodies of all specimens is desirable, and the larger the specimen the thinner the body should be in relation to its width. Convenience in storing is one reason for flattening the bodies. In many collections of study specimens of mammals—for example, those in the University of Kansas Museum of Natural History—the storage cases have the runners so spaced that the distance between the topside of one tray bottom and the underside of the tray bottom next above is $1\frac{15}{16}$ in. Sectional cardboard trays are used for specimens of shrew size and mouse size and reduce the available vertical space to 1⅞ in. or slightly less. (The over-all depth of boxes to house skulls was the factor governing the vertical space between trays.) Because there is only 1⅞ in. of vertical space between trays, the artificial bodies of the smaller mammals, say, chipmunks, are made in such a size that the over-all height of a specimen is less than 1⅞ in. The pinning trays in the collecting-chests (part of the field equipment) have end pieces 1½ in. high. When the trays of freshly stuffed specimens are stacked in the chest, any specimen that is slightly more than the specified height is at once compressed to 1½ in. Once the skin has dried in that space the height will not increase much if any.

Specimens as large as jack rabbits and opossums may need to be slightly deeper than 1½ in. even if the artificial body is much flattened. The height of such a specimen should not exceed 2¾ in., because that height of body is almost the maximum that can be accommodated in a storage case by separating succeeding trays by one additional case-runner. The means of caring for these specimens in the trays of the collecting chest is to stack one empty pinning tray upside down on the pinning tray that contains the jack rabbits or opossums. In actual practice, however, some collectors keep the heights of even opossums and jack rabbits to 1½ in.

In preparing study specimens of mammals, just as in doing other work, different methods will be found for gaining the same result. By slightly altering their methods from year to year, two preparators who used the same methods to begin with will employ appreciably different methods after the lapse of several years. It is understandable therefore that no two preparators of experience use exactly the same methods—and this, I think, is as it should be, for each preparator should constantly strive to improve the quality of his product. The aim should be firm, symmetrical skins free of all fat.

It seems to me that every preparator takes pride in his specimens and derives genuine personal gratification from the contemplation of one of his mammal specimens if well prepared, firmly made, and indelibly and accurately labeled. At such moments he may even consider the possibility that one or another of several especially well-stuffed mice a century hence will be as deservingly spoken of and achieve more of favorable remembrance for him than some other accomplishment at the moment better appreciated by his associates.

A few collectors have immersed skins in a salt-alum bath or treated them with only salt in order to preserve the skins until it was covenient to stuff them. Salt, or salt-alum solution, does alter the color of the pelage. I recommend against using these preserving agents even at a sacrifice in quantity of specimens. Also, it seems to me, that the least that should be done for study skins subjected to the salt-alum treatment or to *any* treatment offering fair like-

lihood of resultant color change is to label the skins at the time of preparation with clear indication of departure from the conventional technique.

A departure that I regard as the lesser of several evils is the soaking of autumn-taken skins of ground squirrels in white gasoline in order to remove surplus fat that may have been released by scraping the flesh side of the skin. Twelve to eighteen hours in gasoline removes the fat. Longer immersion tends to dehydrate the skin, making it difficult to shape properly and making it so brittle after it is dried that it may break. For the skins of some ground squirrels almost ready for hibernation, I know of no substitute for gasoline, carbon tetrachloride, or other compound that removes fat. Such skins that I degreased only by scraping and applying cornmeal or fine sawdust in order to absorb the fat, although seemingly free of fat at the time of stuffing, later showed some greasiness that spread to several parts of the skin and down the thread of the label onto the label. Gross inspection of skins of mammals almost ready to hibernate suggests that there are fat cells *in* the skin of some as well as on the flesh side of the skin. Scraping and using an absorbent such as cornmeal removes most of the fat but not all of it. In spring, when the same kinds of mammals are lean, the soaking of the skin in gasoline or in some other liquid compound is unnecessary—undesirable, in fact.

When a skin has to be washed in soap and water for the purpose of removing dirt, bloodstains, and the like, it can be dried more quickly if its final bath is in white gasoline instead of in water. This is because the gasoline displaces the water and the more volatile gasoline is quickly removed by cornmeal or sawdust in which the skin is buried or with which the skin is repeatedly dusted. Such a skin must be thoroughly dried until the fur is everywhere fluffy before being stuffed; otherwise the fur will always cling together in patches and be unsightly.

Mammal skins to be tanned. Skins that are to be tanned or stuffed at a later date should be cased. Slit the skin from hind feet, down inside of hind legs to base of tail, and split tail full length. Do not open pads of feet on carnivores. In deer, open front legs from "elbow" to hoof.

Fat on skins should be scraped off before skins are stretched for drying. It is not necessary to soak such skins in gasoline.

Do not apply salt, alum, or formalin to skins that are to be relaxed later. Stretch skins that are to dry, flesh-side out, over a board, cardboard, frame of wire, or two poles. When nearly dry, skins as large as those of deer may be rolled up for packing; skins of carnivores should be packed flat, with the tail folded on the body if desired, with a wisp of excelsior between the skins. Be sure that skins dry and that no fly eggs are on the skins when they are packed. Label dried skins with skull tags only.

Preparation of skulls. Skulls should be severed from the vertebral column, using extreme care not to injure the skull. Skulls the size of those of *Spermophilus franklinii* or larger should have the major part of the masseter muscle snipped off to allow the skull to dry quickly.

As soon as possible, skulls should be put in a glass container of cold water to soak for 12 hours, to remove the blood and loosen the brain. In very hot weather it may be necessary to change the water to prevent fermentation.

After removing the skulls from the water, blow out the brains with the aid of a hypodermic fitted with a blunt needle, or with an atomizer bulb fitted with a short rubber tube and blunt hypodermic needle.

Large and small skulls should not be strung on the same wire to dry. If, for example, squirrel and mouse skulls are strung together, some of the smaller skulls certainly will be more or less broken.

Above all, do not allow skulls to become fly blown. This is apt to occur when they are hung up to dry and while soaking, as some will float and thus be exposed to flies. Maggots do much damage by discoloring the bone, loosening the sutures, and obliterating data on tags. Never hang skulls in the sun—always in the shade and, if possible, where there is a breeze. When skulls are quickly dried, any fly eggs deposited will not hatch. If, due to damp weather, the skulls are apt to remain soggy, protect them by cheesecloth (when hung up) to exclude flies. When packing skulls for shipment, or when moving camp, use a container with plenty of air holes. *Never* put damp or even dry skulls in air-tight containers; this causes sweating and maceration. For directions on cleaning mammal skulls, see Jour. Mammalogy, 14(4):372-374, 1933.

Preparation of skeletons. When preparing skeletons, skin the body completely, which means to the tip of the tail and to the claws of the feet. The pads of the feet of mammals and the skin on the tarsi of birds are nearly impervious to the dermestid beetles. Always "draw" the animal and cut off all large muscles. Tag skeletons (each separate piece) in the same way as skulls.

Take care to save baculum, hyoid bones, marsupial bones, patellas, tip of tail, pygostyle, and alula, as these are easily lost. Do not remove tongue or eyes; they contain important bones.

When a skeleton has been roughed out, wrap it with thread or string so that the head and extremities will not be broken off when they are dry and brittle. The legs are pulled up along the body and the head brought back. A few wrappings of thread will suffice for small skeletons. Do not use so much thread that the beetles have difficulty in getting to the meat in the cleaning process. Do not wrap too tightly, as fresh bones are easily bent.

The higher the humidity, the more thoroughly skeletons should be roughed out. Be sure to remove heart and lungs. A mammal skeleton the size of a squirrel's or larger should have its skull detached and its brains removed. Be sure to tie the skull to the body. A skeleton with its skull and leg bones packed in rib basket is slow in drying. Keep sawdust off skeletons. Tie an additional label on skeletons of extremely young animals calling attention to them, so that they will receive extra care in cleaning. See that each separate part has a tag.

Packing and shipping. Keep skins of mammals with you until thoroughly dry. In preparing for shipment, take special pains to pack specimens tight so that they will not move. Much of the smoothness and symmetry may be lost through loose packing.

BIRDS

The tools, preservative, labels, notebook, and other equipment listed as necessary or useful for preparing study specimens of mammals include all that are necessary for preparing study skins of birds.

Proper handling of a bird so that its feathers are unruffled, so that its skin is not torn, and so that blood and other body fluids do not soil the feathers, greatly aid the preparator in turning out an acceptable specimen. A live bird of small size can be killed cleanly and almost instantly by placing the collector's thumb under one wing, the forefinger under the other wing, and pinching sharply. So doing compresses the ribs on the heart and lungs. Killing a bird so large as a Cooper's hawk by the method just described requires more pressure than the average person can exert. Large birds can be killed quickly by opening the mouth and thrusting the blade of a pen knife through the roof of the back part of the mouth into the brain.

Most collectors obtain birds by shooting them. Most collectors use a double-barreled 16 gauge shotgun having a full load of, say, number 6 shot in the left barrel, and an "aux" (metal bushing) chambered to take a 38 caliber shell loaded with fine (no. 12 or dust) shot in the right barrel. The collector can kill a large hawk 40 yards distant by firing the left barrel and can kill a field sparrow no farther away than 18 yards without mutilating it by firing the right barrel.

In order to prevent body fluids from soiling the plumage a plug of cotton should be inserted in the throat of a freshly killed bird. If an eyeball has been punctured it should be removed and a wad of cotton inserted in its place. A plug of cotton can be placed in the anus. Any shot holes that are allowing fluids to emerge can be plugged with small wisps of cotton held in a fine-pointed pair of forceps. Drops of blood on feathers can be scraped off by means of a knife blade. A wad of cotton moistened with water is useful to wipe off blood stains, but a mixture of acetone and carbon tetrachloride is better than water.

In order to protect the plumage, extract a slick-paper magazine from the hunting vest, tear off a sheet, make it into a cornucopia (funnel), twist the small end of the coil in order to prevent it from uncurling, drop the bird, beak foremost, into the cornucopia that is held in the right hand, strike the right wrist sharply and forcefully on the left forearm in order to seat the bird firmly in its protective cornucopia, moisten and again twist the small end to prevent uncurling of the paper, fold in the paper at the large end taking care not to bend the tail feathers, and drop the encased bird in a creel or vasculum carried for that purpose. A creel or vasculum, or even a bag, is better than the pocket of a hunting vest for carrying birds because birds in a hunting vest are likely to be squeezed and so suffer disarrangement of the plumage. Feathers that are broken on a wing or tail almost never can be repaired so as to look natural, but feathers that are merely bent and mussed quickly assume their original shape if held in a jet of steam from the spout of a tea kettle.

If circumstances permit the collector safely to lay the freshly killed bird where the temperature of its body will be lowered to that of the surroundings before he places the bird in its paper cone, putrification of the skin on the abdomen will be delayed.

When a bird is to be skinned remove the plug of cotton from the throat and insert another, fresh plug. Break each humerus (upper arm bone) as near the head of the bone as possible. Lay the bird, back down, on a bed of fine white cornmeal in a shallow container such as a pie tin. With the fingers of the left hand part the feathers on the abdomen and by means of a sharp scalpel in the right hand cut the skin (but not the body wall) from the posterior point of the breast bone to the anus. By means of the left hand apply cornmeal to the incision. Turn the scalpel end for end in the right hand and use the end of the handle of the scalpel to separate the skin from the body wall, working cornmeal into the space between the skin and body.

Lay the scalpel down, grasp the knee of one of the bird's legs between the forefinger and thumb of the right hand, pull the knee out of the skin while the thumb and forefinger of the left hand push the skin down off of the lower leg and thigh, hold the leg in this exposed position by means of the left hand, pick up a pair of scissors in the right hand, and cut off the knee (proximal end of tibiotarsus and distal end of femur). Then, or at a later

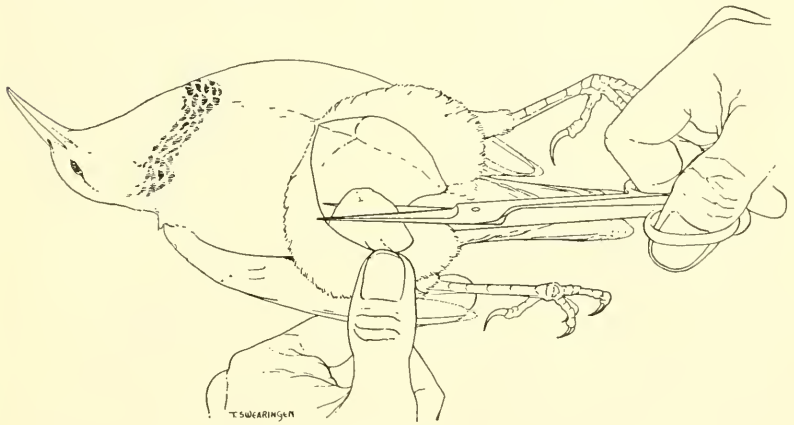


FIG. 17. Cutting off knee. × ⅓.

stage, grasp the severed end of the lower leg in the left hand, twirl (twist) the flesh off of the tibiotarsus, by means of the scissors cut the tendons holding the flesh of the tibiotarsus and cast the flesh aside. Repeat the process on the leg of the opposite side. [In order to save time some preparators break the top off of the tibia with the fingers, thrust the broken bone up through the flesh, and cut the flesh and tendons distally.] Work the skin loose from the body down to and nearly around the base of the tail. Insert one blade of the scissors on either side of the pygostyle (tail bone), cut the bone (taking care not to cut the skin on the top of the tail bone), and free the skin from the tail region of the back. Push (do not pull) the skin of the back, sides and breast toward the head. At the place where the upper arm bone was broken, cut the muscles attaching the wing to the body. Tearing them in two by means of the finger nails saves time. Push skin over neck and over head by means of nails on thumb and fingers. On arrival at head, push the skin gradually so that it stretches enough to slip over the widest part of skull. On wood-

peckers and ducks it is difficult to work the skin of the neck over the head. In those birds slit the skin on the top of the neck at the back of the skull and sever the neck where it joins the skull. After the skin is stuffed, the slit on top of the neck, of course, has to be sewed shut.

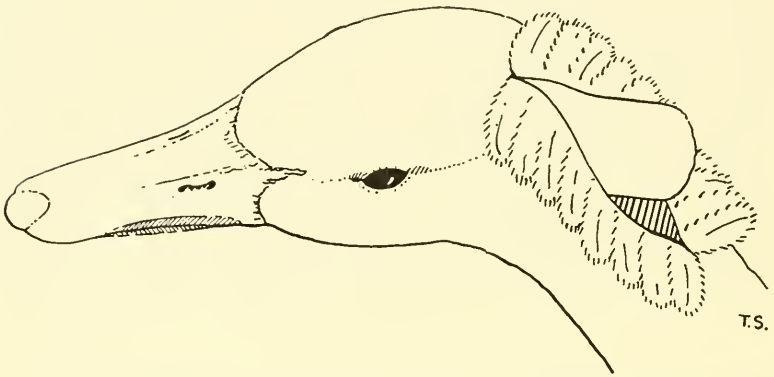


FIG. 18. Showing slit in skin at back of head. Cut end of neck projects out of slit in skin. Such a slit is necessary in geese and woodpeckers when the skin is to be turned over the head. × ½.

The membranous tube of skin extending into each ear can be pulled out of the ear by grasping the tube between the nails of the thumb and a finger. Pushing the skin on toward the beak reveals the eyeballs, each under its translucent membrane that connects the eye with the eyelids. By means of forceps reach beneath the eyeball, grasp the optic nerve, and remove the eyeball without puncturing it. Cut through the translucent membrane without cutting either eyelid. Cut away any part of the membrane still attached to the eyelids because the membrane interferes with exposing the cotton ball that later will replace the eyeball. Practice and experience enable a person to severe the membrane by means of a single stroke of the scalpel or a single snip of the scissors. Fluid from a punctured eyeball soils feathers. Push skin

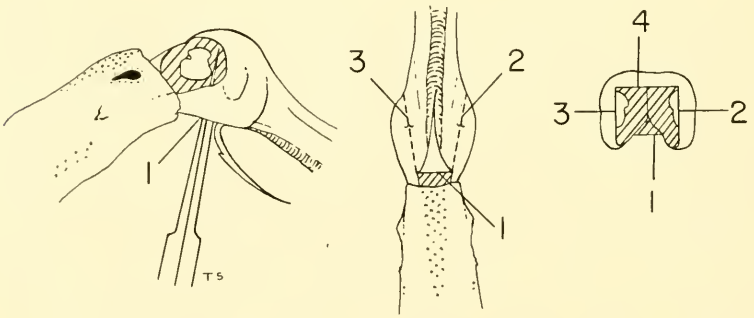


FIG. 19. Showing several steps to be taken in separating neck from the skull that is left attached to the skin. × ½.

to base of bill. Liberal use of cornmeal at all stages soaks up body fluids and keeps the skin and preparator's fingers clean.

By means of forceps, grasp tongue and pull it backward out of the way. Cast aside the cotton plug that was in throat if the plug is in the way.

Cut directly across roof of mouth when points of scissors are high up in the back parts of the eye sockets, taking care not to cut the lateral supports of either the upper jaws or lower jaws. Next, within the branches of the lower mandible, use scissors to cut from one end of the preceding cut to the back of the skull (figure 19), thereby cutting through one side of the braincase; repeat process on opposite side of skull. Cut across back of skull above the neck so as to connect the ends of the two side cuts. Pull the neck loose from the head, thereby removing the base of the skull and part or all of the brain. Remove any brain tissue that remains and see that a large opening connects each orbit with the brain cavity.

Part the skin on each wing so as to reveal the radius and ulna. Remove flesh from these bones. Do not free so much of the skin from the wing as to loosen the ends of the primary feathers. The ends of the secondaries also should be left in place. In birds as large as a Swainson's hawk, the skin of the wing should be opened on the under side (figure 20); the flesh and tendons are removed; arsenical soap or powder is applied; enough cotton is laid in the wing to replace the muscles; the cut edges of the skin are sewed together by means of a few stitches of white cotton thread.

Separate the skin from the base of the tail bone; cut and scrape away most

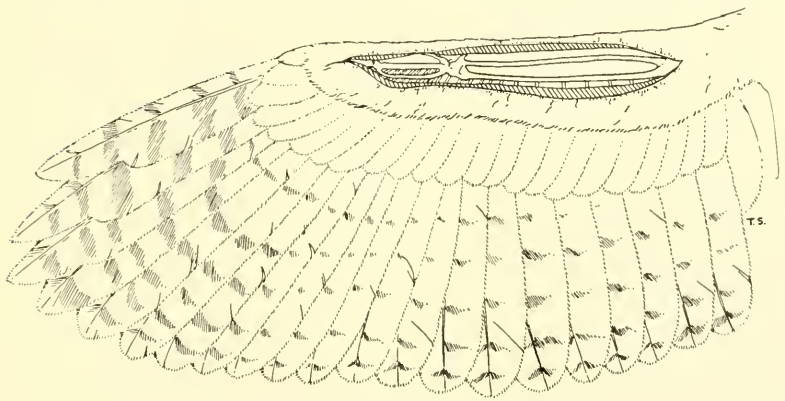


FIG. 20. Opening on underside of owl's wing. Principal muscles have been removed thereby exposing bones. × ½.

of the flesh and all of the fat including the oil gland. Exercise care not to loosen or cut off the bases of the tail feathers. Leave the tail bone in place.

Wind barely enough cotton on each leg bone to replace the muscles.

Remove any flesh and especially all fat from the skin. Sew up any large tears.

Thoroughly poison the flesh side of the skin with arsenic powder or arsenical soap.

Turn skin right side out. Form a hard ball of cotton slightly smaller than the eyeball, securely grasp the ball with forceps, insert it forward through the neck into proper position in the orbit. See that the cotton ball for the second orbit is of the same size as the ball for the first.

Beginners will do well to tie the wing bones together as shown in figure 21, and some experienced preparators do so. Some persons instead tie the feather tracts nearly together (see figure 22). The objective is to anchor the wings so that they will not fall away from the body and ultimately be broken off. Proper placement of the wings, after the body is stuffed, is the requirement and some preparators regularly place the wings in correct position without sewing together the wing bones or the feather tracts. See figure 26.

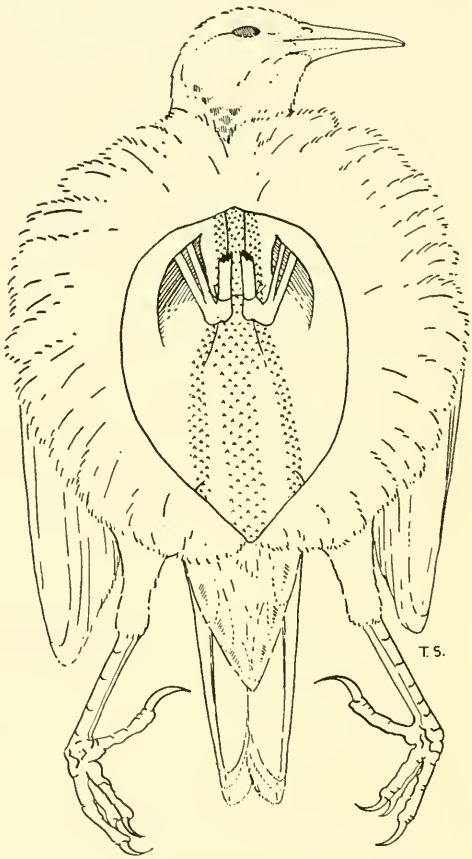


FIG. 21. Wing-bones tied together. × ½.

In birds as large as eagles, larger hawks and the great blue heron it is advisable to remove the tendons from the legs and feet. By making an incision in the skin of the sole of the foot a tendon can be caught by means of a metal hook and pulled out as illustrated in figure 23. Lacking a suitable hook, the preparator can thrust a 12 penny spike beneath a tendon and pull it out of its sheath in the leg.

In birds the size of a sage grouse, formalin (1 part of formaldehyde to 8 parts of water) injected into the soles of the feet prevents rapid decay of the muscles and tendons. If the skins having the feet so treated with formalin are in a place favorable for drying, the feet ultimately dry without evidence of decay.

When the eyes (cotton balls) are in place, a body can be wrapped on a stick (see figure 24). Fibers of cotton that project out from the cotton body increase its size. Consequently, the aim is to shape a body that appears to be slightly smaller than the skinned body. Lay the cotton body along side the skinned body in order to make the breast deep enough and the body as

a whole small enough. The neck must be shorter than the neck that was removed.

Insert the pointed end of the neck into the throat; adjust the skin on the body, taking care to see that the skin is not twisted and that both the skin and the artificial body are bilaterally symmetrical. See figure 25. By means of sharp-pointed forceps, grasp cotton at the pointed end of the stick and force the cotton through the bony palate at the base of bill so that the head will not slip forward. By means of one loop of thread through the nostrils, tie the mandibles together. Remove this thread when the specimen has dried. By means of two or three stitches sew up the incision on the abdomen.

Almost no two preparators construct a cotton body in exactly the same fashion. Some insert two pieces of cotton and one acquaintance who prepares excellent skins inserts three pieces. A symmetrical skin to which the head, wings, legs and tail are firmly attached and in correct position is, of course, the requirement.

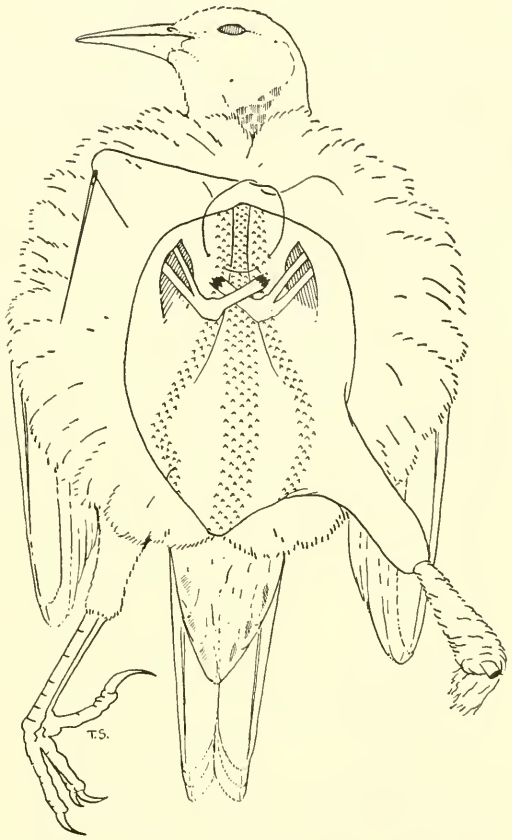


FIG. 22. One step in tying together feather tracts. × ½.

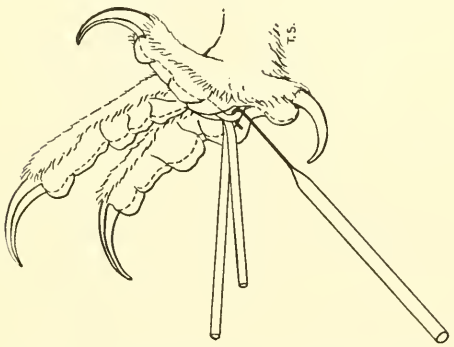


FIG. 23. Pulling tendons from leg and foot of a large hawk. × ½.

Next arrange the wings in proper position. See that the anterior bend of each wing is in the apterium (area lacking feathers) on the side of the neck. A

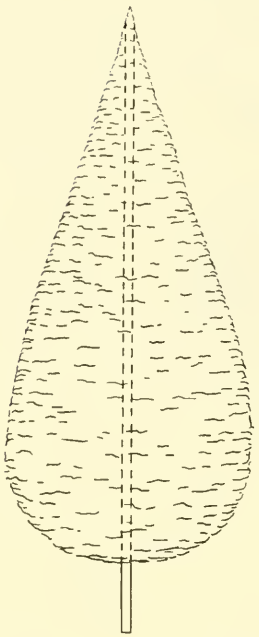


FIG. 24. Cotton body wrapped on a wooden support. × ½.

(see figure 26), the anterior points of which are in the apteria. With the parts of the stuffed skin thus in place the skin is symmetrically wrapped in a thin sheet of cotton and laid on its back to dry, or the skin is laid in a trough, of appropriate size, of paper or of cotton. By either method the wings must be kept together (touching) on the back instead of being allowed to rest naturally one on either side of the body. Contour feathers of the outer breast can be laid over the edge of the wing.

By opening the abdomen of the skinned body the sex is ascertained (see figure 27).

right-handed person places the right thumb under one wing and a right finger under the other wing. By means of the left hand the skin of the back is gently lifted free of the artificial body and the thumb and finger of the right hand are brought together on the back at the bases of the two wings. By deft use of the fingers of both hands the wings are made to lie together (touching) on the back, and the intervening skin of the back folds half to the right and half to the left over the wings

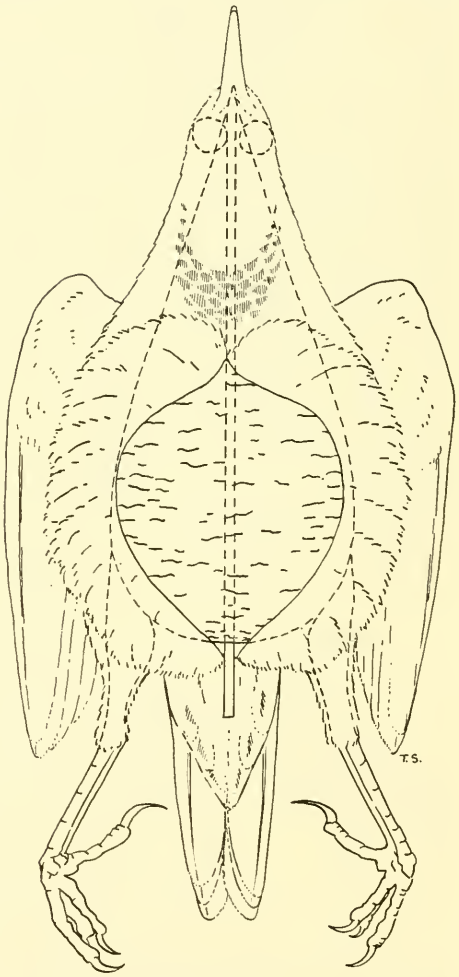


FIG. 25. Cotton body in place. × ½.

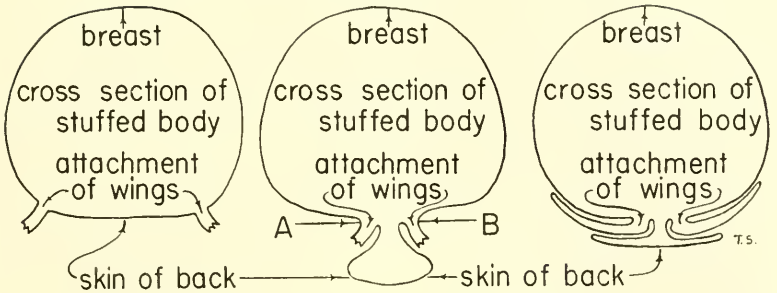


FIG. 26. Vertical section through stuffed body showing three stages in bringing wings together on the back. × ½.

In immature birds and in non-breeding adults the gonads (ovary and testes) are almost microscopic in size and great care must be used to ascertain the sex. The gonads are large in breeding birds and determination of their sex is correspondingly easy. When in doubt about the sex enter a question mark on the label in the space reserved for the sex symbol.

Feet of the skin are tied together by a double loop of the white cotton thread attached to the label. When the legs and feet are symmetrically arranged the tail feathers are spread to the desired degree and the posterior

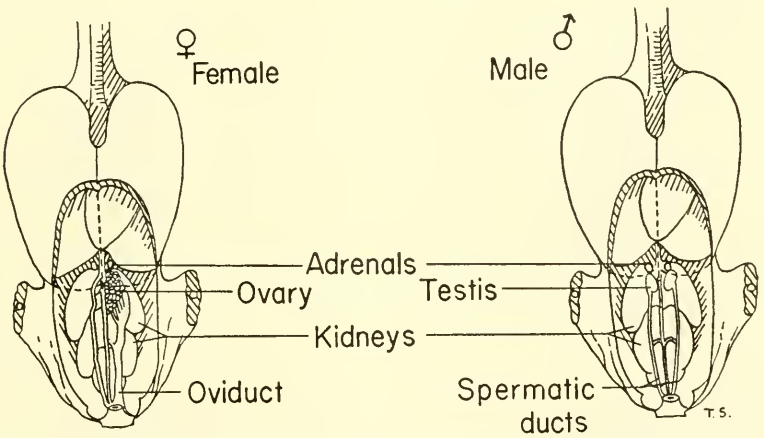
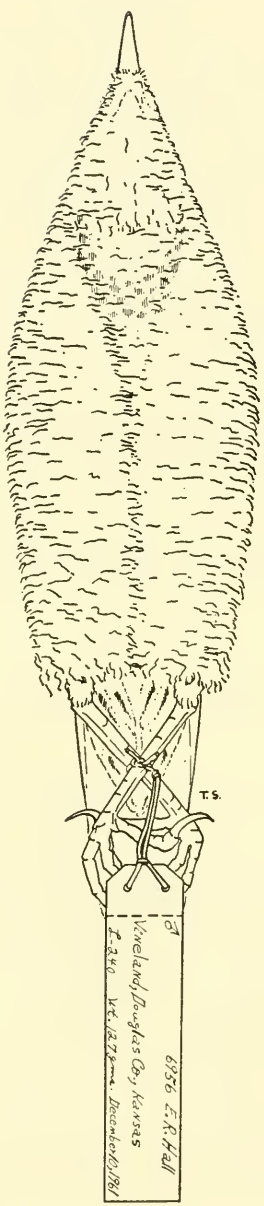


FIG. 27. Diagram of gonads and some other reproductive organs. × ⅓.

tips of the wings are symmetrically placed. See figure 28. In this form the skin is allowed to set (dry). Inspection when partly dry is worthwhile for the beginner because he may be able to correct some irregularities before the skin has firmly set.

After the skin has dried, the cotton wrapping can be removed (see figure 29) and the loop of thread holding the two parts of the bill together should be cut and removed.

Removing all fat from the skin is important because fat left on a skin



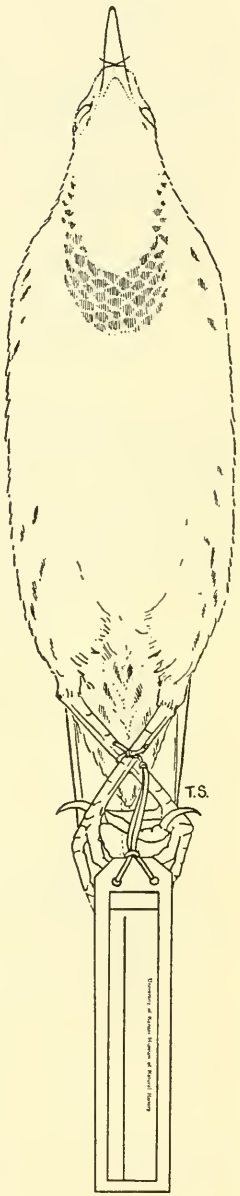


FIG. 28. Skin wrapped in thin layer of cotton (on left), laid on back to dry.
FIG. 29. Dried skin (on right) from which cotton wrapping has been removed.
Each × ½.

ultimately breaks down, soaks out, mats the feathers, collects dust, oxidizes and makes the skin fall apart. On some fat ducks, for example, tough tissue containing fat cells connects the bases of the feathers. A tool consisting of five phonograph needles soldered to a metal base having a handle (see figure 30) is useful in breaking up the fatty tissue. Then most of the tissue can be scraped away by means of a dull knife. Repeated applications of warm cornmeal absorb much of the remaining fat. In such instances it is rarely if ever possible to remove all of the fat by the process just described. Most fat skins so prepared reveal grease at a later time. If a fat skin is being prepared in a well-equipped shop, it is advisable to take additional steps as follows: wash skin in cold water to remove any blood; wash skin next in a weak solution of a household detergent, rinse well, squeeze as dry as possible, and then alternately massage and squeeze the skin for 15 minutes in white gasoline. After squeezing as much gasoline as possible out of the skin, apply cornmeal, working it into the feathers. Shake out and use compressed air for final drying and fluffing, repeating application of cornmeal and compressed air until feathers are dry.

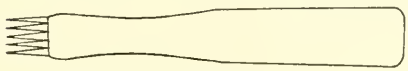


FIG. 30. Five phonograph needles soldered to metal handle. Used to break up fat and remove it from flesh-side of feather tracts. × ½.

SKELETONS OF BIRDS

Obtain list of particular desiderata from the curator. Collect adults that are on their breeding grounds or that are resident. Enter in notebook same data as for a skin.

Use only individuals having long bones and skulls intact. Skin off and save body feathers; leave distal remiges and rectices in place. Ascertain sex, remove viscera as well as large part of muscles on breast and thighs. Leave eyes and brain in skull.

Fold limbs and neck back onto skeleton of body and wrap lightly with white cotton thread (No. 8 or No. 12); do not wrap so as to bend "green" bones or primaries.

Affix skull tag (with sex, field number, and your initials on one side and genus and species on other side) to skeleton. Wrap up body feathers in paper or insert in envelope. Write on paper or envelope same data as is on skull tag.

Hang skeletons *in shade* to dry. If drying takes long enough that fly larvae may develop, protect skeleton with cheesecloth to prevent skeleton from becoming fly blown. After skeletons are dry, store them in an airy place; do not keep in air-tight container because it will cause "sweating," resulting in the growth of mold and maceration of some skeletons.

For shipping use stout wooden box having ports for air circulation. Skeletons and skins are to be shipped in separate boxes; dermestid beetles, grease from skeletons, and other "by products" can injure stuffed skins.

PACKING FOR SHIPMENT

Keep skins of birds with you until they are thoroughly dry. The thin layer of cotton can be left on the skin that is to be packed for shipment. Use a wooden or metal box that has some slits or holes allowing air to circulate. Pack

skins backs-down, in layers; each layer should be one skin deep; bills (not tails) should be in contact with the ends, or sides, of the box. Insert wads of cotton in the spaces between the skins so that those of each layer are packed tightly enough not to move. Place a layer, one-fourth inch thick, of resilient cotton over the layer of skins. On top of this layer of cotton place a paper or thin cardboard in order to make a flat surface for the next higher layer of skins and on top of the paper place a film of cotton for the purpose of making a non-skid surface. Do not pack large heavy skins in same box with small light skins because so doing will cause the latter to be crushed.

Skeletons are to be boxed separately from skins. Skeletons can be wrapped individually in paper. Cotton, fine excelsior, or some other resilient material can be used to fill in the spaces between the paper-wrapped skeletons in order to prevent them from moving while the box is in transit.

Slight odors from packages of specimens have caused some employees of some transportation companies to discard packages in the belief that the contents have "spoiled" and are, therefore, of no use or value to the person or agency to which the packages are addressed. Packages that are insured are less likely to be discarded for such a reason than are uninsured packages. Consequently, some insurance for a parcel of specimens is indicated, whether the parcel is sent by mail or by express.

DIRECTIONS FOR PRESERVING AMPHIBIANS AND REPTILES

BY

WILLIAM E. DUELLMAN

Specimens of amphibians and reptiles are preserved in liquids—either formalin or alcohol. Five major steps in the preparation of these specimens are described below:

1. KILLING

Since most specimens of amphibians and reptiles are collected alive, some method of killing the animals is required. Specimens should be killed in a manner that will leave them completely relaxed, so that the animal may be fixed in the desired position. Reptiles of any size are best killed by hypodermic injection of dilute Pentobarbital Sodium, which is sold in some drugstores and supply houses under the commercial name of "Nembutal" at a concentration of one gram per cc. (NOTE: Use only aqueous veterinarian Nembutal, not the syrupy elixir.) For purposes of killing reptiles, dilute the commercial Nembutal with nine parts of water for each part of Nembutal. Mix only the quantity that is needed, for a mixed solution soon becomes ineffective. Small snakes and lizards require only a few drops of this solution; larger snakes (more than two feet in length), large lizards, and turtles require one cc or more, depending upon the size. The solution should be injected into or near the heart. Death occurs quickly, often in a matter of seconds. Specimens killed in this manner are completely relaxed.

Other methods of killing reptiles include immersion in warm water (110-120° F) until they have succumbed, or the injection of preservative into the heart or body cavity. If animals are killed by immersion, care must be exercised to remove them from the water immediately after death; otherwise they will become rigid in the position in which they died. Specimens killed by injection of preservative in the heart often die in contorted positions and cannot be relaxed for proper fixing.

Amphibians are best killed by drowning in a solution of Hydrous Chlorobutanol, which is sold commercially under the name of "Chloretone." A few crystals of Chloretone in a quart of water make a suitable killing solution. If kept tightly capped, it may be used over and over. In a fresh solution, amphibians die in a few minutes; in old solutions more time is required. Specimens should be removed from the solution shortly after death, so that they do not harden in the positions in which they died. Also, a dilute (10%) solution of ethyl alcohol can be used as a killing solution. Care must be exercised to remove the specimens immediately upon death. Amphibians can be killed by injection of preservative into the body cavity, but this method results in badly distorted specimens that are of limited use in scientific study.

2. PREPARATION

Formalin is the best preservative for injection and fixing of specimens of amphibians and reptiles. Formalin is the commercial name for formaldehyde gas in water and is sold in drugstores and chemical supply houses in a strength of 40 per cent. In Latin American countries, formalin can be purchased in drugstores under the name of "Formol" or "Formolina." In Latin America

the strength may be less than 40 per cent; consequently inquiry should be made at the time of purchase. For injection and fixing specimens the commercial formalin should be diluted with nine parts of water. Thus, one quart of formalin will make two and one-half gallons of preservative. Ethyl alcohol can be used for preparation, but the cost of the alcohol and its bulk make it impractical for use in the field. Ethyl alcohol usually is sold in a strength of 95 per cent. For injection and fixing of reptiles it should be used at full strength; for amphibians, it should be diluted: three parts of alcohol to one part of water. Storage of specimens should be in a solution of two parts of alcohol to one part of water.

In order to insure the proper preservation of specimens, it is necessary to introduce liquid preservative into the body cavity, limbs, and tail. For best results, formalin should be injected into the body cavity. Care must be taken to insure that the preservative reaches all parts of the body; furthermore, care should be taken not to over-inject. Put enough formalin in the body to make it look natural, but not enough to bloat the body, because bloating destroys some features of importance. Small salamanders and many small frogs do not need to be injected. For larger frogs, toads, and salamanders a single injection in the body cavity usually suffices. In lizards injection should be made into the body cavity, and, in the case of larger specimens, in the limbs. Snakes should be injected in several places to insure that the preservative reaches all parts of the body cavity. Injection of turtles should be made at points in front of each of the limbs until the body cavity is full; the limbs, neck and tail also should be injected. Small crocodilians are injected in the same manner as lizards.

Tails of lizards, snakes, turtles, and crocodilians should be slit by means of a sharp scalpel or razor blade. In turtles, crocodilians, and larger lizards slits should be made in the limbs and feet. If possible, one hemipenis of each male lizard and snake should be everted. This is accomplished by injecting preservative into the base of the tail (before slitting) and at the same time applying pressure with the thumb behind the anus (Fig. 31).

Exceptionally large snakes, lizards, and crocodilians should be skinned. Before specimens are skinned, they should be measured. When skinning reptiles, leave the head, tail, and in the case of lizards and crocodilians, the hands and feet intact. Simply remove the body, leaving the head and tail attached. Skinning is best accomplished by slitting the specimen immediately to one side of the midline. A piece of cloth should be placed against the inside of the skin, which is then rolled and placed in preservative.

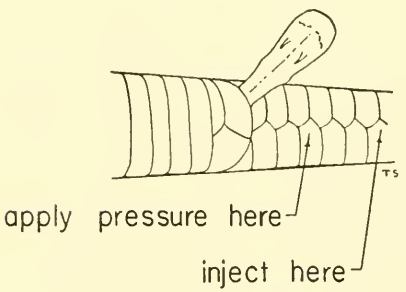


FIG. 31. Left hemipenis, of a snake, everted. × 1.

Tadpoles and small salamander larvae should be dropped into 10 per cent formalin, never in alcohol. Care should be taken to see that the specimens are not crowded. After 24 hours the preservative should be replaced with fresh 10 per cent formalin.

If equipment for injection is not available, preservative can be introduced into the body cavities of all amphibians and reptiles by making one or more (as needed) deep slits in the ventral surface of the body. This method, however, is not so satisfactory as injection.

3. FIXING

After a specimen has been killed and injected with preservative, it should be placed in the desired position to harden. Many collectors simply drop their specimens into formalin and allow them to harden in any position. A little extra time is required to lay out the specimens in trays, but the effort is repaid over and over, for specimens that have been hardened in a proper position are much easier to store and study than are others. For hardening

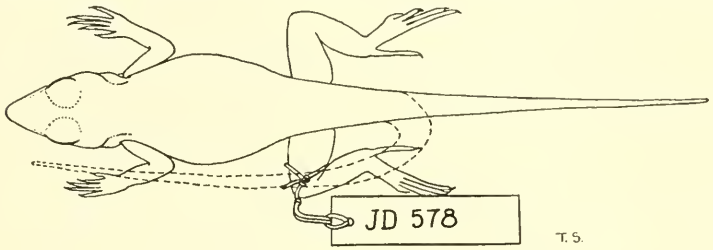


FIG. 32. Lizard having legs and tail in proper positions. × 1.

specimens, trays made of plastic, glass, or rustproof metal can be used. Cover the bottom of the tray with wet paper (paper towels are good). Place the specimens on the paper, cover them with another wet paper towel, and place about ¼ inch of preservative in the tray. Amphibians will harden in a few hours; most reptiles will harden in six to eight hours.

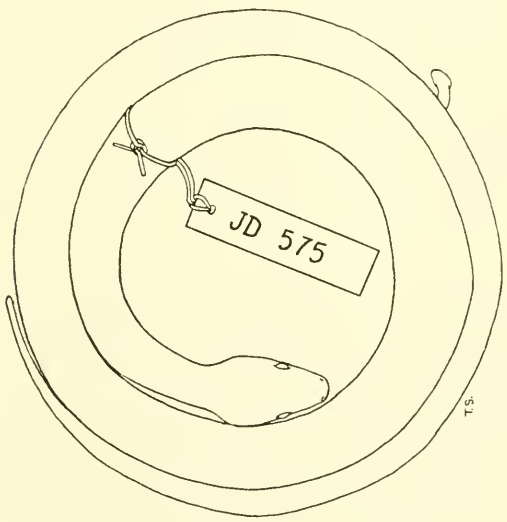


FIG. 33. Small snake coiled in correct position. × 1.

Lizards and salamanders are placed belly down on the trays with their limbs and tail extended (Fig. 32). If the tail is long it can be bent alongside the body. Small snakes can be coiled flat on a tray (Fig. 33), belly down; never make a coil larger than about three inches in diameter. Larger snakes should be coiled in bottles. The necks and

limbs of turtles should be extended. In fixing turtles it is important that the mouth be held open. A stone or piece of wood can be used to hold the jaws apart. Frogs and toads are placed belly down on trays, with arms and legs

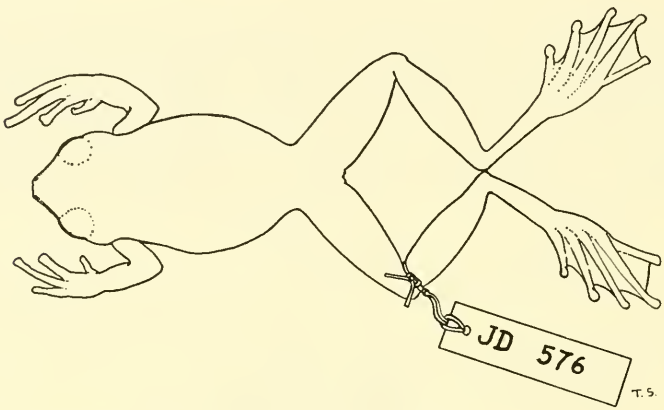


FIG. 34. Frog having limbs in correct position. × 1.

extended as shown in Figure 34. The fingers and toes should be separated and extended. The sole of the foot should be up or down, whichever seems most natural (down in treefrogs and up in most other frogs and toads).

4. LABELING

The large tags used for study skins of mammals and birds can be used for amphibians and reptiles, but their use is not recommended. It is better to use small parchment tags, on which is written the collector's field number that is recorded in his field book along with the data for each specimen. A tag should be attached to every specimen, except to tadpoles and small salamander larvae, which are catalogued as lots. Tags should be tied (with a square knot) immediately below the knee of the left hind leg in lizards, frogs, toads, and turtles. Small lizards, small frogs, and all salamanders should have the tag tied around the waist. Tags should be tied on snakes well back of the head but in front of the thickest part of the body (Fig. 33).

5. STORAGE

If possible, after the specimens are hardened keep them in glass or other rustproof containers filled with 10 per cent formalin. Specimens should not be tightly packed in the containers. Completely immerse all specimens in formalin for at least 48 hours, after which time, if the specimens are well preserved, they can be removed from liquid and wrapped loosely in cheesecloth and placed in plastic bags. Pour just enough formalin in each bag to wet the specimens and cheesecloth thoroughly. Twist the top of the bag and fasten securely with a rubber band. Plastic bags filled with specimens can be stored in boxes or preferably metal cans. Care should be taken to place heavy specimens on the bottom and lighter specimens on top.

COLLECTING AND PRESERVING FISHES

BY

FRANK B. CROSS

References: Hubbs, Carl L., and Lagler, Karl F., "Fishes of the Great Lakes Region," Cranbrook Inst. Sci., Bull. 26:xiii + 213 pp., illustrated; 1958. Lagler, Karl F., "Freshwater Fishery Biology," Wm. C. Brown Co., Dubuque, Iowa, x + 360 pp., 172 figs., 1952.

The following instructions are intended for the serious student of fishes, who wishes to derive a maximum of information from his collecting effort. The amateur collectors whose interests are mainly in keeping a few fishes for casual observation, or in obtaining an identification of some species unknown to him, may lack the time or facilities for following all these recommendations. Although he should read fully these instructions and follow them insofar as possible, he can do a certain amount of collecting quickly, easily, and economically. The essentials are formaldehyde (obtainable in many drugstores) and a jar to contain the specimens. The formaldehyde, as purchased, must be diluted with approximately nine parts of water before it is used. The specimens can be left permanently in this solution if it is buffered by addition of one teaspoon of borax per quart of diluted formaldehyde.

If the collector has arranged with the Curator at the Museum to send his fishes to the Museum for identification, they may be sent in the following ways: wrap the specimens in soft cloths moistened with dilute formaldehyde, and pack carefully in a paint can or other tight, friction-sealed can, which can be sent by mail or express without danger of drying of the specimens; or place the specimens with moistened cotton or cloth in a plastic bag, tie the open end of the bag tightly, and pack the bag carefully in a wooden box for shipment. The specimens should, of course, always have labels stating where they were caught, when, and by whom.

Methods of Collecting

Fishes may be collected by a variety of devices. Hook-and-line, seines, gill nets, trammel nets, hoop- or fyke-nets, traps, poison, and electrical shockers are devices commonly used in fresh water. Each of these devices is selective, in some degree, of cerain kinds or sizes of fishes. Therefore it is desirable to employ several methods to obtain a representative sample of the total fauna from any given locality. Poison, such as powdered Derris root or Cubé root mixed with water, so as to make a soupy solution, is used to best advantage in backwater areas along streams or in small bays of lakes, where dispersal of the poison can be restricted. Portable electric shockers are the most effective devices for sampling clear, fast-flowing, rocky streams. Gill nets, hoop nets, and traps are most useful for sampling large, deep lakes or sluggish streams, although hoop nets may also be used effectively in relatively fast-flowing, deep water. All such nets are made in several mesh sizes. Gill nets are highly selective of limited kinds and sizes of fishes unless a series of different mesh sizes is used.

For qualitative surveys most collectors rely on seines, of one-quarter-inch mesh, in lengths of 10 feet to 25 feet. A heavily-leaded seine 4 feet or 6 feet long, made from small-mesh woven nylon, is especially useful for collecting

along brushy shores or in riffles in streams. Bag seines, with a long pocket of netting in the middle, are good for effective sampling of lakes or large rivers.

Stretch all linen or cotton nets to dry as soon as possible after use. Rapid drying greatly reduces the rate of deterioration of these nets. The life of such nets can be prolonged by treatment with a preservative such as copper naphthenate. Nets made wholly of nylon need not be dried or treated, but are weakened by prolonged exposure to intense sunlight.

Field Containers

The most satisfactory field containers are wide-mouthed, galvanized milk cans with lids and wire bails. The can need not be large, but should be tall enough to contain the largest specimen likely to be included in the sample. Wide-mouthed glass "pickle" jars in gallon size, or half-gallon fruit-canning jars, also make suitable and inexpensive containers, but are subject to breakage and consequent loss of the collection, especially in fast-flowing, rocky streams.

Collecting and Preserving

Fishes should be killed immediately upon capture in a preservative mixture consisting of nine parts water and one part concentrated formalin (aqueous solution containing 36 to 40 per cent formaldehyde gas). All specimens may be placed in the same container. Those more than six inches long should be slit open along the *right side* of the abdomen to facilitate penetration of the preservative. Smaller fishes, or extremely slender ones, need not be incised or otherwise prepared for fixation. Fishes placed in preservative while still alive make much the best specimens. The largest specimens thus preserved should be removed for incision after they have been killed, and then placed back in the preservative.

The collector should overlook no available habitats in any body of water he works. He should thoroughly investigate shallow riffles, undercut banks, and the depths of pools in proportion to their occurrence in the situation being studied. Kicking or dislodging large stones or submerged debris often yields species whose presence would not be discovered if these methods were neglected. Just as some fishes are selective as to habitat, others are active and susceptible to capture at different times of day. For this reason dual collections obtained from the same locality at night and in the daytime are desirable. The time interval in which the sample was taken always should be stated in the field notes.

The collector should strive to obtain a representative sample of the various species and size groups constituting the population, and should preserve a fixed percentage of the total number of individuals of each species captured. Because nearly all collectors deviate from the practice just described in order to secure adequate series of rare species, the degree to which the abundance was biased by the collector's selectivity should be indicated on the sheet of field data. This may be done in a general sense by assigning to each species a number corresponding to its position in descending order of abundance, or by application of one of the terms, "abundant," "common," "frequent," "scarce," or "rare."

Labels and Field Notes

Immediately after the collection is completed, prepare field notes and a label for the container of specimens. These should be written in Higgins Eternal Ink or Higgins Engrossing Ink, the latter having the advantage that it

need not be washed before being placed in the preservative solution. Data on the label should include the state, county, section, township, and range (or comparable information where these categories are not applicable), the name of the stream or lake from which the sample was taken, the date of capture, and the names and field numbers of the collectors. The field notes should be more comprehensive, as indicated below and in other sections of these instructions. The collector's field number, the date, and the time interval in which the collection was made should be entered at the top of the sheet. The locality, the method of capture, and the temperature of the air and water should then be recorded. Additional data will vary depending upon the type of habitat being studied. Desirable notes of collections from streams include: turbidity and evidence of pollution; average width, average depth, and maximum depth of stream; ratio of riffles to pools, and the average length of each; rate of flow in feet per second (this may be estimated by recording the time required for twigs thrown into the water to traverse a measured length of stream); volume of flow in cubic feet per second (rate of flow $\times$ average depth $\times$ average width); type of stream-bottom materials including the proportions made up by bed rock, boulders, rubble, gravel, sand, or mud; kinds and abundance of aquatic plants and macroscopic invertebrate animals; and the extent and nature of streamside cover. Finally, a list of the species taken should be recorded, together with notes on the habitat occupied by each species, and any special notes on coloration, spawning activity, *etc.*, observed in individual specimens. Detailed notes have not been made on some of our commonest fishes. Descriptions of coloration, especially of colors developed during the spawning season, are important, because the fishes fade in formaldehyde or alcohol, and are best described from living or freshly-preserved specimens.

Subsequent Handling of Specimens

After the specimens have been in the preservative solution for three days to a week (depending upon the size of the individuals), soak them thoroughly in water for two to four days. Change water several times in this interval. Transfer specimens to 70 per cent ethyl alcohol, or 40 per cent isopropyl alcohol. Change this alcohol or restore it to the proper strength, before the specimens are placed in permanent storage. Thereafter, check the solutions at yearly intervals and maintain proper strength. If this is not done, evaporation from the jars eventually will reduce the percentage of alcohol and the specimens will become soft.

The collection may be sorted, separating the species represented, at any time after washing. Consult the field notes and correct the list of species, if necessary, during the sorting process. It is usually desirable to reserve a single container for all specimens of each species obtained in a single collection, and to catalogue the species by "lots," rather than individually. Large specimens should be placed in containers tail-first. Suitable storage containers include fruit-canning jars in one-half pint to one-half gallon sizes, patent-lip vials in 4-dram and 8-dram sizes, and tanks, made of monel metal or stainless steel, which have been designed for zoological specimens. All containers should be tightly sealed. Screw-type, metal-lid jars are undesirable, but may be used if new lids with gaskets are available for replacement as the old ones become rusty.

A label, written with Higgins Eternal Ink, or Engrossing Ink, stating the

name of the species, the catalogue number, the number of specimens, the locality, the collector, and the date of capture should be placed in the container with each lot of specimens. Space may be saved by utilizing vials for short series of small specimens, and placing in a larger jar several vials of the same species, taken at different times or localities. Each vial must contain its own label and alcohol, and its mouth must be tightly plugged with cotton. Efficient use of space may also require storage of large specimens from several collections in the same container. Such specimens must be catalogued individually and a label of tin, plastic tape, or tough paper of high rag content must be attached securely to each specimen by sewing the label to the caudal peduncle.

FOSSIL VERTEBRATES

References on field techniques: Camp, C. L., and Hanna, G. D. "Methods in Paleontology," Univ. California Press, Berkeley, Calif., 1937. Hermann, A., "Modern Laboratory Methods in Vertebrate Paleontology," Bull. Amer. Mus. Nat. Hist., vol. 26, pp. 283-381, 1909. Simpson, G. G., "How Fossils are Collected," Natural Hist., vol. 39, pp. 329-334, 1937.

Equipment

For general prospecting, each person should be equipped with the following: Marsh pick, awl (protect point with small cork), whisk broom, small paint brush, wrapping paper, paper bags, string, field labels, tobacco tin, Scot [toilet] Tissue, large pocket knife, collecting bag, notebook, and several 8H pencils. Many collectors carry in addition to the above such items as shellac bottle with enclosed brush, rice paper, trowel, and hand lens. Equipment necessarily varies with field conditions.

Finding Fossils

In prospecting, work upstream and from base of an exposure upward. Save all fragments until you are sure the lead is valueless. If material is located which is worth collecting, save these fragments and be sure they can be identified with the specimen. If the size of the area prevents exhaustive searching then follow stream courses and ridge-tops. In any case do not remain on the same stratigraphic level until after fossil zones are established. In areas of tilted and folded strata this means that the collector should work back and forth across the strike of the beds.

A specimen is of little value unless the geographic location and stratigraphic position are known as exactly as possible. Hence obtain as much of the following data as possible for isolated specimens, and as much as is pertinent for any specimen: (1) geologic age (2) sketch map showing location and columnar (vertical) section indicating stratigraphic position (3) land location to quarter quarter-section (4) triangulation to prominent land marks if a Brunton compass is available (5) lithology and conditions of deposition. If necessary collect and label a rock sample. In locating specimens avoid such expressions as "brown house," "Jones Ranch" although these may be used as supplementary information. Do not attempt to collect specimens with inadequate equipment. Mark site plainly, cover specimen if necessary, and return when the proper equipment is available.

Any collector should be alert to reports of fossils or of objects thought to be fossils and should investigate such reports.

At least two groups of youths of boy scout age that channeled their outdoor activities to collecting fossils have recently made important discoveries. In the process they initially learned the techniques for removing fossils and of course learned by their own efforts a substantial amount of geology and biology.

Excavation of Specimens

In working a quarry or taking out large specimens avoid tunneling or undercutting specimen or fossil layer. Remove all overburden for a considerable distance on all sides away from area of immediate work. If the presence of a microfauna is indicated, dry the matrix and sieve it. Disintegrate silt or clay

in running water to recover material of small size. Frequently, specimens will have to be treated with white shellac thinned with alcohol. Use only gum arabic for specimens in chalk. Use thin alvar for gluing and on fragile specimens, but allow specimen to dry before applying the alvar. Do not leave specimens exposed overnight. Lay paper over specimens and cover with earth.

If specimen must be jacketed, undercut the block slightly before applying jacket. Cut loose-weave burlap into strips approximately four inches wide and soak in water. Cover exposed bones with two or three layers of wet toilet paper. Soak burlap strips in thin moulding plaster and bandage the block. Allow plaster to set thoroughly. Complete undercutting of specimen, turn block over, trim, and bandage the under surface. Do not smooth raw plaster over jacket. Leave plenty of matrix on specimen—that is to say, do not attempt to prepare specimen in field. Take notes in field in regard to condition of specimen or anything else which will assist the laboratory preparator in removing the specimen.

FIELD NOTES

Each person should keep a combined daily journal and field book in which is entered such data as: time of arrival and departure, weather (in foreign countries especially), route traveled, exposures visited, exact localities, sketches, notes on geology, measured sections, specimens collected with locality and your catalogue field number, names, addresses, and comments on people met during field work. On a museum field trip the notes as well as the specimens are the property of the Museum. It is well to remember that the entire party receives credit for material found or collected by a member; do not try to outrace other members of the party either during prospecting or quarry operations.

In addition, if the party is large and operating over a long period of time, catalogue all specimens in a separate field book. The field numbers should also be attached to the specimen or engraved in the plaster packets. Each collector whether working as a group member or alone uses his own field numbers which are consecutive and carry his initials. Thus J.E.D. 30 indicates the thirtieth specimen collected by John E. Doe during his Museum career.

The field journal should be kept on the standard note book paper. Use only a very hard pencil (7H to 9H) or Higgins Eternal Ink. Write only on one side of note book paper. Each page should carry a page number in the upper right-hand corner, and your name and year in the upper left-hand corner. Leave sufficient margin for future binding.

Transmitted April 2, 1962.

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